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TABLE OF CONTENTS FIRST PAGE

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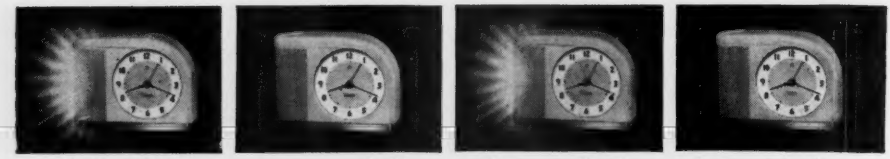

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CONTENTS

Original Articles

Malformations, Anomalies, and Vestigial Structures of the Inner Ear PAGE
Franz Altmann, M.D., New York 591

Foreign Bodies in Air and Food Passages
Wen-Chih Hung, M.D., and Pen-Jen Lin, M.D., Taipei, Taiwan 603

Research in Otology in the United States in 1952
Douglas Macfarlan, M.D., Philadelphia 613

Auditory Tube and Tympanic Cavity During Embryonal, Fetal, and Prenatal Life
Marvin J. Tamari, M.D., Chicago 627

Nystagmus Electrically Recorded
Helge Hertz, M.D., and Niels Riskaer, M.D., Copenhagen, Denmark 648

Gastroscopy for the Otolaryngologist
Joseph Shanks, M.D., Chicago 658

Parental Evaluation of Tonsil and Adenoid Removal
James S. Walker, M.D., Urbana, Ill. 664

Improvement of Low-Tone Deafness and Tinnitus by Mandibular Repositioning
S. H. Ronkin, D.D.S., New York 669

"Silent" Cholesteatoma
Robert Henner, M.D., and Marvin Tamari, M.D., Chicago 674

Case Reports

Sheet of Tantalum to Replace Alae of Thyroid Cartilage
George Douvlaris, M.D., Athens, Greece 681

Clinical Notes, New Instruments and Techniques

Use of Polyethylene Tubing in Nasal Sinus Surgery
Fordyce Johnson, M.D., Pasadena, Calif. 683

Progress in Otolaryngology

Tonsils and Adenoids
Louis E. Adin Jr., M.D., and J. Dudley Singleton, M.D., Dallas, Texas 686

Special Reports

Hearing Aids Accepted by the Council on Physical Medicine and Rehabilitation of the American Medical Association, as of June 1, 1953 705

Regular Departments

News and Comment 708

Directory of Otolaryngological Societies 709

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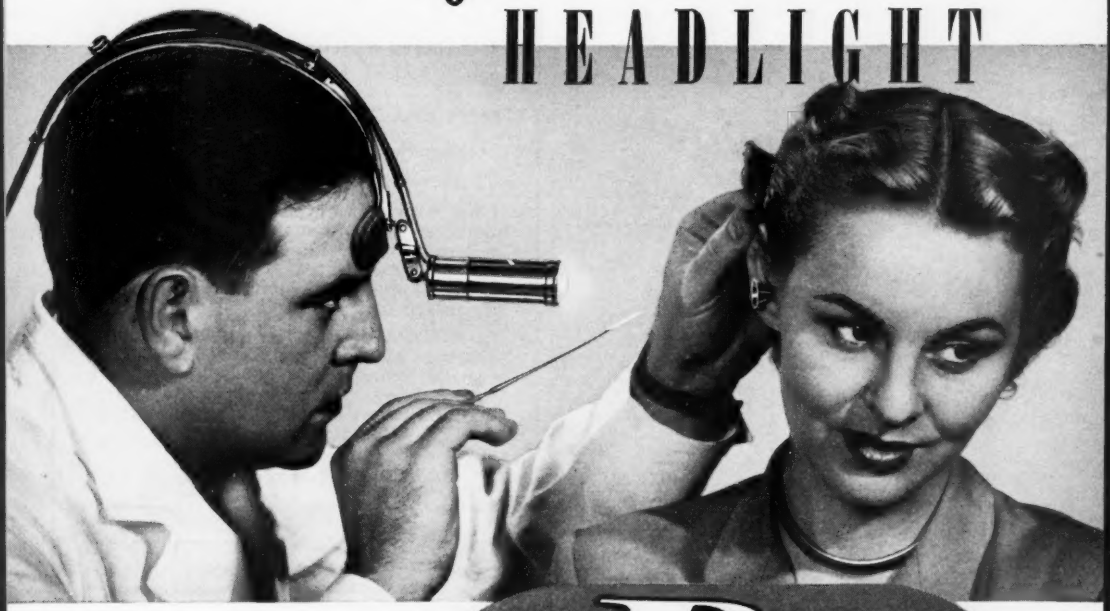

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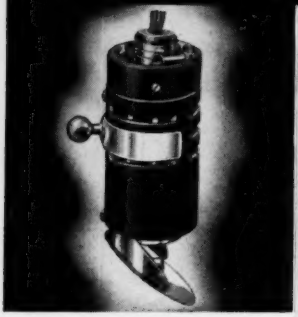

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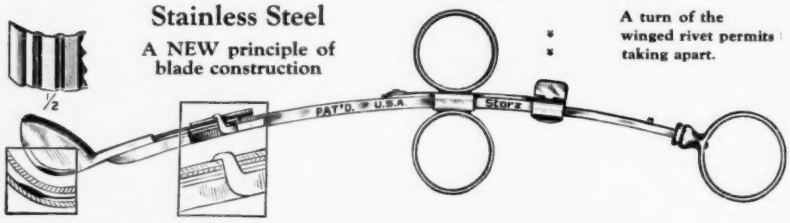

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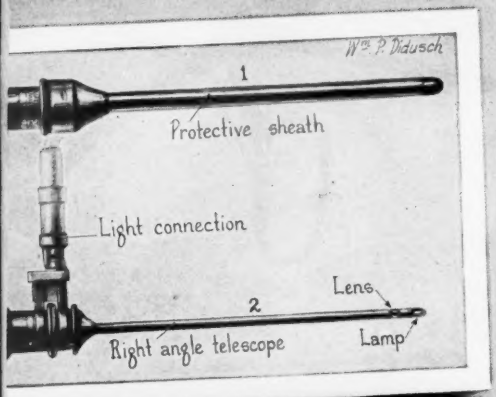

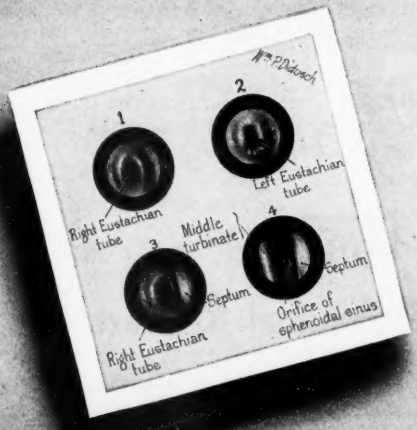

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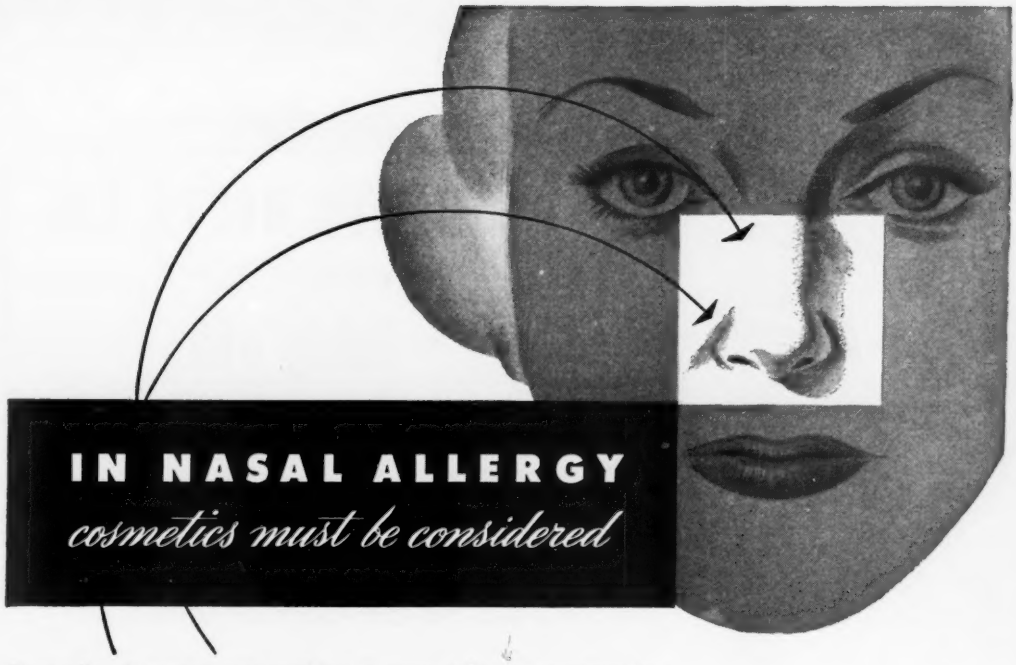

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MALFORMATIONS, ANOMALIES, AND VESTIGIAL STRUCTURES OF THE INNER EAR

FRANZ ALTMANN, M.D.
NEW YORK

ANOMALIES and malformations of the inner ear are uncommon. The majority of them are found either together with abnormalities of the external and middle ear, in cases of so-called congenital atresia, or, as a rule, without other malformations, in inherited nerve deafness. The latter abnormalities have been reviewed in an earlier paper (Altmann [1]).

The structures discussed in this paper are primarily of interest to anatomists and embryologists. Certain anomalies of the osseous capsule of the labyrinth have, however, lately aroused considerable interest among otologists because of their possible relationship to the development of otosclerotic foci.

MEMBRANOUS LABYRINTH

In discussing malformations of the membranous labyrinth, the phylogenetically older pars superior will be reviewed first.

Variations in the mode of origin of the endolymphatic duct from the utricle and saccule (Bast [2]; Bast and Anson [3]) should be noted. In about 83% of the cases observed, the angle between the utricular and the saccular ducts was found to be acute. These two ducts and the endolymphatic duct form a Y, in which the stem is represented by the endolymphatic duct and the two arms by the utricular and saccular ducts. Fourteen per cent of the observations showed the utricular duct to be very short, forming either a right angle or an acute angle with the endolymphatic duct and an obtuse angle with the saccular duct. About 3% presented virtually no utricular duct, and the utricle communicated through a slit-like opening with the endolymphatic duct. Werner [4] described a slit-like communication between the saccule and the utricle in an adult guinea pig. He explained this condition to

This study was aided by grants from the Research Council of the American Otological Society, Inc., and the Hayden-Coakley Fund.

From the Department of Otolaryngology, Columbia University College of Physicians and Surgeons, Director, Edmund P. Fowler, Jr., M.D.

1. Altmann, F.: Histologic Picture of Inherited Nerve Deafness in Man and Animals, Arch. Otolaryng. **51**:852, 1950.

2. Bast, T. H.: The Utriculo-Endolymphatic Valve and Duct and Its Relation to the Endolymphatic and Saccular Ducts in Man and Guinea Pig, Anat. Rec. **68**:75, 1937.

3. Bast, T. H., and Anson, B. J.: The Temporal Bone and the Ear, Springfield, Ill., Charles C Thomas, Publisher, 1949.

4. Werner, C. F.: Über das Verhältnis der Vorhofsäckchen zueinander und zum Ductus endolymphaticus auf Grund einer Hemmungsmissbildung beim Meerschweinchen, Anat. Anz. **87**:248, 1938.

be the result of impeded development, of an incomplete separation between saccule and utricle. Werner believes also that normally no separate duct exists between the saccule and the endolymphatic duct and that the utricle in mammals merely opens into an elongated recess of the saccule. The endolymphatic duct follows after the opening of the utricular duct into the saccular recess.

Papillary epithelial proliferations can be seen in young human embryos occasionally, at the place where the endolymphatic duct originates from the utricular and saccular ducts. Apparently they represent remnants of small diverticula which were present during early embryonic stages (Kolmer [5]).

In rare instances the lumen of the endolymphatic sac proper is subdivided into numerous small channel-like spaces (Alexander [6]; Fischer [7]). In addition, two of Alexander's cases [6b,e] showed a wide vestibular aqueduct which contained a dural septum; the endolymphatic duct and sac, instead of running posterolaterally towards the posterior vertical canal and the sigmoid sinus, extended anteromedially towards the internal auditory meatus.

Frequently in the wall of the utricle one finds areas which show an atypical structure (*atypische Gewebsformationen,* Alexander [8]). The most common finding is a small hillock in the inferior sinus of the utricle close to the ampulla of the posterior vertical canal and near the opening of the utricular duct—the so-called crista quarta (Benjamins [9]; macula neglecta, Retzius [10]; papilla neglecta, de Burlet [11]). This is a low ridge, measuring in adults 15 to 75 μ in height and 10 to 60 μ in width, which is covered with cuboidal or columnar epithelium which gradually merges with the surrounding low epithelium. The underlying stroma is rich in capillaries and sometimes contains pigment cells (Fischer [12]; Ruttin [13]) but no

5. Kolmer, W.: Gehörorgan, in Handbuch der mikroskopischen Anatomie des Menschen, edited by W. von Möllendorff, Vol. 3, Pt. 1, Berlin, Springer-Verlag, 1927, p. 297.

6. Alexander, G.: (*a*) Entwicklung und Bau des inneren Gehörorganes von Echidna aculeata, Verhandl. Gesellsch. deutsch. Naturf. u. Aerzte, (Pt. 2) **2**:340, 1904; (*b*) Zur Pathologie und pathologischen Anatomie der kongenitalen Taubheit, Arch. Ohren- Nasen- u. Kehlkopfh. **61**:183, 1904; (*c*) Zur Frage der phylogenetischen, vikariierenden Ausbildung der Sinnesorgane: Über das statische und das Gehörorgan von Tieren mit kongenital defektem Sehapparat; Maulwurf (Talpa europaea) und Blindmaus (Sphalax typhlus), Ztschr. Psychol. Sinnesorgane **38**:24, 1905; (*d*) Zur Anatomie der congenitalen Taubheit, Pt. 2: Anatomie der Taubstummheit, Wiesbaden, J. F. Bergmann, 1905; (*e*) Über Atrophie des labyrinthären Sinnesepithels (Labyrinthatrophie und Obliteration der Pars inferior), ein Beitrag zur Klinik und Anatomie der erworbenen Taubheit, Arch. Ohren- Nasen- u. Kehlkopfh. **74**:112, 1907.

7. Fischer, J.: Eine Macula utriculi accessoria beim Menschen nebst anderen kongenitalen Missbildungen des inneren Ohres, Monatsschr. Ohrenh. **65**:517, 1931.

8. Alexander, G.: Über atypische Gewebsformationen im häutigen Labyrinth, Arch. Ohren- Nasen- u. Kehlkopfh. **55**:54, 1902.

9. Benjamins, C. E.: Beitrag zur Kenntnis des häutigen Labyrinthes: Über eine vierte Crista acustica, Ztschr. Ohren. **68**:101, 1913.

10. Retzius, G.: Das Gehörorgan der Wirbelthiere: Morphologische- histologische Studien, Vol. 2: Das Gehörorgan der Reptilien, der Vögel und der Säugethiere, Stockholm, Samson & Wallin, 1884.

11. deBurlet, H. M.: Über die Papilla neglecta, Anat. Anz. **66**:199, 1928.

12. Fischer, J.: Zur Entwicklung der atypischen Gewebsformationen im häutigen Innenohr, Ztschr. Hals- Nasen- u. Ohrenh. **3**:177, 1922.

13. Ruttin, E.: Zur normalen und pathologischen Anatomie des Utriculus und der Cysterna perilymphatica, Acta oto-laryng. **3**:289, 1922.

nerve fibers. Only in two six-month-old fetuses (Benjamins[9]; Wolff[14]) was the epithelium differentiated into hair cells and sustentacular cells and covered by a rudimentary cupula. The structure was supplied in both instances by nerve fibers originating from the posterior branch of the vestibular nerve.

The structure in question was first described as it occurs in man by Wittmaack[15] and afterwards was studied by Stütz,[16] Benjamins,[9] Masuda,[17] Fischer,[18] Sakai,[19] Ruttin,[13] Mayer,[20] Tanturri,[21] Eckert-Möbius,[22] Brunner,[23] Wolff,[14] Werner,[24] Eggston and Wolff,[25] Altmann,[1] and others. According to Sakai[19] this structure is found in adult men in 88% of the cases, in children in 90%, and in fetuses in 95%.

The crista quarta develops, according to Stütz, from a low ridge extending in embryos from the lower part of the anterior wall of the utricle along the inferior wall of the inferior sinus near the ampulla of the posterior vertical canal upward over the medial wall to the roof of the utricle. The same ridge in several mammals had already been described by Denis[26] and by Fleissig,[27] a fact evidently overlooked by Stütz. In late fetal life the ridge becomes considerably reduced in size, and the remnants form the crista quarta. According to Benjamins, the part of the ridge which persists gives rise to two structures, the crista quarta and a rounded structure near the opening of the lean end of the horizontal canal into the utricle. The latter formation is less frequently found; its epithelial covering is cuboidal or low columnar and fails to show any further differentiation or cupula. The stroma

14. Wolff, D.: Significant Anatomic Features of the Auditory Mechanism with Special Reference to the Late Fetus, Ann. Otol. Rhin. & Laryng. **43**:193, 1934.

15. Wittmaack, K.: Über sogenannte atypische Epithelformen im membranösen Labyrinth, Verhandl. deutsch. Otol. Ges. **20**:406, 1911.

16. Stütz, L.: Über die sog. atypischen Gewebsformationen im häutigen Labyrinth: Eine rudimentäre Macula neglecta, Morphol. Jahrb. **44**:403, 1912.

17. Masuda: Beiträge zur Kenntnis der vierten Crista des menschlichen Ohrlabyrinthes, Ztschr. Otol. (Japan) **25**:1914; cited by Kolmer.[5]

18. Fischer, J.: (*a*) Zur Frage des konstitutionell-kongenitalen Charakters der Otosklerose: Morphologische Anomalien des Innenohres als Ausdruck der konstitutionellen Minderwertigkeit des Gehörorganes, Monatsschr. Ohrenh. **55**:127, 1921; (*b*) footnote 12.

19. Sakai, K.: Findet sich die Macula neglecta auch beim Menschen? Ztschr. Ohrenh. **82**:50, 1922.

20. Mayer, O.: Bericht über die Ergebnisse weiterer Untersuchungen zur Otosklerosefrage, Ztschr. Hals- Nasen- u. Ohrenh. **6**:280, 1923.

21. Tanturri, V.: La formazione atipica del labirinto (macula o crista neglecta), Morgagni **66**:390, 1924.

22. Eckert-Möbius, A.: Untersuchungstechnik und Histologie des Gehörorgans, in Handbuch der Hals-Nasen-Ohren-Heilkunde, edited by A. Denker, and O. Kahler, Vol. 6: Die Krankheiten des Gehörorgans, Berlin, Springer-Verlag, 1926, p. 211.

23. Brunner, H.: Pathologie und Klinik der Erkrankungen des Innenohres nach stumpfen Schädeltraumen, Monatsschr. Ohrenh. **59**:697, 1925.

24. Werner, C. F.: Das Labyrinth: Bau, Funktionen und Krankheiten des Innenohres: Vom Standpunkte der experimentellen und vergleichenden Pathologie, Leipzig, Georg Thieme, 1940.

25. Eggston, A. A., and Wolff, D.: Histopathology of the Ear, Nose and Throat, Baltimore, Williams & Wilkins Company, 1947.

26. Denis, P.: Recherches sur le développement de l'oreille interne chez les mammifères (Vespertilio murinus), Arch. biol. **18**:377, 1902.

27. Fleissig, J.: Die Entwickelung des Geckolabyrinthes, ein Beitrag zur Entwickelung des Reptilienlabyrinthes, Anat. Hefte **37**:1, 1908.

is always free from nerve fibers. Fischer [12] found that the extent and degree of development of the ridge during embryonic life varies and that other smaller ridges might also be present in the medial wall of the utricle and in the saccule. Rudiments of them might be found in various places in the upper part of the medial wall and in the roof of the utricle.

A crista quarta is found in all vertebrates from fish to man. In mammals it was first observed by Alexander in the echidna [6a] and mole [6c] and later by numerous authors in other species (Stütz,[16] Benjamins,[9] Kolmer,[28] Sakai,[19] Bruni,[29] Miyamoto,[30] and Werner.[24] Although the degree of differentiation varies, the crista quarta is as a rule better developed in other mammals than in man. In most instances the epithelium consists only of sustentacular cells, but it sometimes also contains more or less well-developed hair cells. It is often covered with a cupula-like jelly which contains no otoliths. It is sometimes supplied by branches of the posterior ramus of the vestibular nerve. Among the common laboratory animals the cupula is apparently regularly present in dogs, cats, and mice, rare in guinea pigs, and evidently absent in rabbits (Werner [24]). A fold in the utricular wall of mammalian fetuses similar to that described in man and giving rise to the crista quarta and the rounded structure near the opening of the horizontal canal was, as already mentioned, first seen by Denis [26] and Fleissig [27]; Benjamins,[9] however, was the first to recognize its significance. The crista quarta of mammals and man is almost generally regarded as homologous with the macula neglecta described by Retzius [10] at the same location in fishes, reptiles, and birds. Benjamins points out that the crista in all orders of the vertebrates shows the characteristic structure of a crista and not a macula and therefore introduced the term crista quarta to replace macula neglecta.

According to de Burlet,[31] the sensularium usually shows the character of a cupula but in fishes occasionally contains otoliths. For this reason he prefers the neutral term papilla neglecta to macula neglecta or crista quarta. Retzius [10] and Alexander [2c] had assumed that the neuroepithelium of the crista quarta is derived from the part of the macula communis which develops into the neuroepithelium of the crista posterior. According to Stibbe [32] it is derived from the anlage of the macula utriculi. Alexander [33] and Fischer [12] believe that at present there is no definite proof to permit the homologization of the structure in question with the macula neglecta of the lower vertebrates. According to them a true macula neglecta should be diagnosed only if the area in question not only occupies the same site as in lower vertebrates but also contains sensory cells, sustentacular cells, and otoliths.

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28. Kolmer, W.: Studien am Labyrinth von Insektivoren, Sitzungsb. Akad. Wiss. Math.-naturw. Cl. **122**:29, 1913; footnote 5.

29. Bruni: Appunta sulla morfologia della pars neglecta del labirinto acustico di Bufo vulgaris, Atti Soc. science nat. Milano, 1924; cited by Kolmer.[5]

30. Miyamoto, T.: Über eine akzessorische Nervenendstelle im häutigen Labyrinth des Meerschweinchens, Ztschr. Otol. (Japan) **36**:26, 1930.

31. deBurlet, H. M.: Vergleichende Anatomie des stato-akustischen Organes, in Handbuch der vergleichenden Anatomie der Wirbeltiere, edited by L. Bolk; E. Göppert; E. Kallius, and W. Lubosch, Vol. 2, Pt. 2, Berlin, Urban & Schwarzenberg, 1934, p. 1293; footnote 11.

32. Stibbe, F. H.: Bijdrage tot de kennis omtrent de ontwikkeling der Crista quarta, Thesis, Utrecht, 1921.

33. Alexander, G.: Über das Auftreten von akzessorischen Neuroepithelflecken im menschlichen Ohrlabyrinth, Monatsschr. Ohrenh. **54**:772, 1920.

These prerequisites were, according to Fischer, fulfilled in two cases only (Alexander [33]; Fischer [18a]).

In Alexander's case there were two accessory end-organs on the floor of the utricle, laterad from the macula utriculi; they contained sustentacular cells and degenerated nerve cells covered with otoliths. In Fischer's case an end-organ was seen in the anterior wall of the sinus utriculi which not only showed the typical structure of the macula utriculi but also contained medullated nerve fibers which could be traced to the epithelial cells. Mayer [20] saw in two cases at the same place a "macula-like" epithelium and a strand of tissue running from the posterior ampullar nerve to the epithelium. It did not, however, contain nerve fibers. If we bear in mind the fact that according to Benjamins the so-called macula neglecta is histologically, at least in mammals, not a macula but a crista, it becomes difficult to understand how a structure with the histologic characteristics of a crista should represent the homologon of the macula neglecta of Retzius.

A peculiar malformation of the utricle with an unknown significance was described by Fischer.[34] The utricle was incompletely divided by a circular fold into a larger medial and a smaller lateral part. The fold arose from the macula utriculi and contained on its lateral surface rudimentary sensory epithelium. Nerve fibers could be traced into the septum and from there to the sensory elements on the medial surface of the septum.

Mayer [20] in three cases observed a sac-like formation arising from the well-developed macula utriculi. It projected either freely, "like a flag" into the utricular lumen or was firmly attached to the underlying tissue. The wall of the sac had a slightly fibrillar texture, and the lumen contained granular masses. The macular epithelium at the point of origin of this anomalous structure was low and contained colloid globules.

Less marked anomalies of the epithelial lining such as intraepithelial cyst formations or sac-like evaginations of the epithelium into the underlying tissue, sometimes with cyst formation, are not uncommon, particularly in the peripheral parts of the macula, less frequently in the plana semilunata of the cristae ampullares (Alexander [35]; Kolmer [5]; Fischer [7]). Multiple cysts filled with a hyaline substance within the epithelial covering of the crista ampullaris of the posterior vertical canal were reported by Mayer.[36]

Gross malformations of the semicircular canals, such as abnormal narrowing or a persistent pocket-shaped anlage of the canal with normal configuration of the ampulla, are sometimes found. These may be present with or without other malformations and are most frequently found in the lateral canal (Siebenmann [37]). In other cases there may be a pocket-shaped anlage of the lateral semicircular canal on one side and a normal formation of the canal with a defect of the bone inside

34. Fischer, J.: Eine bisher nicht beobachtete Missbildung im häutigen Labyrinth, Ztschr. Hals- Nasen- u. Ohrenh. **25**:582, 1930; footnote 7.

35. Alexander, G.: (*a*) Pathologische Anatomie der nervösen Anteile des Gehörorganes, in Handbuch der Neurologie des Ohres, edited by G. Alexander, and O. Marburg, Vol. 1, Berlin, Urban & Schwarzenberg, 1924, p. 701; (*b*) footnote 8.

36. Mayer, O.: Epithelcysten an einer Crista acustica, Arch. Ohren- Nasen- u. Kehlkopfh. **74**:78, 1907.

37. Siebenmann, F.: Die Korrosions-Anatomie des knöchernen Labyrinthes des menschlichen Ohres, Wiesbaden, J. F. Bergmann, 1890.

the convexity of the canal on the opposite side (Altmann [38]). In a case reported by Barth [39] the crus simplex of the lateral semicircular canal was situated abnormally close to the posterior vertical canal. In a circumscribed area the two canals were separated from each other by a thin layer of connective tissue instead of bone. A similar condition is sometimes found in normal as well as waltzing mice (Alexander and Kreidl [40]). In birds the bony lateral and posterior vertical canals actually fuse at their intersection and form a common bony canal without a dividing connective tissue septum. In a case reported by Brunner and Urbantschitsch [41]) the lean end of the membranous lateral semicircular canal opened into the common crus of the two vertical canals instead of into the utricle. Moulonguet and Bouche [42] claim that in a patient operated on for otosclerosis there was a congenital absence of the semicircular canals on the side operated on, while the canals were present on the other side.

Occasionally, in the course of a fenestration operation, the lumen of the lateral semicircular canal is found to be filled with bone. Such cases were encountered by Boyd, Lempert (from personal communications to the author), and others. This finding is, however, not a malformation but the result of a healed infection. It shows clearly the great importance of careful preoperative vestibular studies.

Sometimes one finds several roots of the posterior ampullar nerve or a temporary separation of a nerve bundle from the chief trunk of the nerve. Occasionally groups of ganglionic cells are seen within the utriculoampullar or the posterior ampullar nerve within the internal auditory meatus (Alexander [35a]). In rare cases the nerve is completely absent but the posterior ampulla appears normal (Altmann [38]). In other instances the crista is covered by a layer of columnar cells and the cupula is absent (Hofmann [43]).

Severe malformations of the semicircular canals have, as a rule, been observed only in cases of atresia auris congenita. One finds a persistence of the common pocket-shaped anlage of the superior and posterior vertical canals. Varying degrees of hypoplasia or an absence of some or all semicircular canals associated with other malformations, such as rudimentary anlage of the utricle, are sometimes found. All these malformations are associated with corresponding malformations of the bony capsule. For details see Altmann.[44] The malformations of the pars superior, especially if they are not too severe, may be found as isolated conditions. If they are severe, they are, as a rule, associated with malformations of the pars inferior. In the severest cases of malformation of the middle ear, but also in one case in which the

38. Altmann, F.: Zur Anatomie und formalen Genese der Atresia auris congenita, Monatsschr. Ohrenh. **67**:765, 1933.

39. Barth, H.: Über eine anatomische Anomalie des Bogengangsapparates, Ztschr. Hals-Nasen- u. Ohrenh. **31**:375, 1932.

40. Alexander, G., and Kreidl, A.: Anatomisch-physiologische Studien über das Ohrlabyrinth der Tanzmaus, Arch. ges. Physiol. **88**:509, 1902.

41. Brunner, H., and Urbantschitsch, E.: Zur Kenntnis der hereditärdegenerativen Taubstummheit, Arch. Ohren- Nasen- u. Kehlkopfh. **120**:43, 1929.

42. Moulonguet, A., and Bouche, J.: Absence congénital d'appareil semi-circulaire, Ann. oto-laryng. **65**:333, 1948.

43. Hofmann, L.: Zwei Fälle von seltenen anatomischen Befunden am Schläfebein, Monatsschr. Ohrenh. **59**:402, 1925.

44. Altmann, F.: Problem of So-Called Congenital Atresia of the Ear: Histologic Report of New Case, Arch. Otolaryng. **50**:759, 1949; footnote 38.

external and middle ear was found to be almost normal (Michel [45]), a complete absence of the labyrinth was reported.

The malformations of the pars inferior are very important from a clinical point of view, because they include the case of inherited nerve deafness (Altmann [1]).

Slight malformations of the pars inferior with apparently normal function are very rare as far as can be determined from the histologic picture.

Occasionally one finds in the neighborhood of the macula sacculi and in the spiral ligament, the crista spiralis, or the lamina tectoria, the same small epithelial cysts and saccular evaginations as are found in the utricle and the semicircular canals; Reissner's membrane may show small accumulations of epithelial cells (Alexander [35a]). Fischer [12] describes in embryos a ridge in the saccular wall near the origin of the saccular duct. In an adult [7] he saw a small ridge in the saccular wall above the macula. It was covered by regular saccular epithelium and its stroma contained some capillaries.

Mention should also be made of the outpocketings on the medial wall of the saccule near the orifice of the sacculoendolymphatic duct, observed by Anson [46] in rare instances in embryos of 18.8 to 40 mm. They disappear in later stages without leaving a trace.

Crowe, Guild, and Polvogt [47] reported a case in which Reissner's membrane was very much convoluted, consisting of a layer of cuboidal cells on the ductus cochlearis surface with small blood vessels on the scala vestibuli side 5.5 to 7 mm. from the basal end. Histologically, this resembled the choroid plexus. The tegmentum vasculosum of the bird ear, which corresponds to Reissner's membrane in mammals, has a somewhat similar appearance.

Slight anomalies of the stria vascularis are not uncommon, particularly the presence of large blood vessels underneath the superficial epithelial layer, with thickening of the stria and bulging into the lumen of the cochlear duct (Mayer [20]; Fischer [7]). In a case described by Alexander [35a] the stria of the basal cochlear turn consisted of a ridge-like prominence of dense vascular tissue covered with high columnar epithelium. A similar configuration of the stria in all turns was seen in a horse by Cohrs.[48] Wolff [49] observed an anomalous capillary plexus in the scala tympani of the basal turn. Two capillaries came from under the tunnel of Corti and from the labium spirale and united in the lumen of the scala tympani into one vessel which proceeded to the lower border of the spiral ligament. Similar observations were reported by Guild [50] and by Polvogt and Crowe.[51] Alexander [35a] mentions

45. Michel: Mémoire sur les anomalies congénitales de l'oreille interne, Gaz. méd. Strasbourg **3**:55, 1863.

46. Anson, B. J.: Saccular Diverticula in the Membranous Labyrinth of Mammalian Embryos, Quart. Bull. Northwestern Univ. M. School **20**:421, 1946.

47. Crowe, S. J.; Guild, S. R., and Polvogt, L. M.: Observations on Pathology of High-Tone Deafness, Bull. Johns Hopkins Hosp. **54**:315, 1934.

48. Cohrs, P.: Studien zur normalen und pathologischen Anatomie und Histologie des inneren Gehörorganes vom Pferde (Equus caballus): Beitrag zur primären isolierten peripheren Cochlear-Degeneration, Arch. Ohren- Nasen- u. Kehlkopfh. **118**:1, 1928.

49. Wolff, D.: Anomalous Capillary Plexus in Scala Tympani, Arch. Otolaryng. **22**:44, 1935.

50. Guild, S. R.: Symposium: Tone Localization in the Cochlea; Discussion from the Point of View of Studies on Human Temporal Bones, Ann. Otol. Rhin. & Laryng. **44**:738, 1935.

51. Polvogt, L. M., and Crowe, S. J.: Anomalies of Cochlea in Patients with Normal Hearing, Ann. Otol. Rhin. & Laryng. **46**:579, 1937.

that occasionally a strand of connective tissue is seen extending in the apical turn from the floor of the scala tympani to the free edge of the hamulus. The condition seems to be an embryological residuum due to incomplete resorption of the mesenchyme during the formation of the lumen of the scala tympani.

Occasionally epithelial thickenings are found in the medial wall of the ductus reuniens (Alexander [35a]). Kolmer [52] saw nonmyelinated nerve fibers connected with such an epithelial mound in a 5-month-old embryo. He regarded the mound as a rudiment of the macula lagenae of the lower vertebrates and as a homologon of the papilla ductus reunientis which was described by Alexander in fetuses of guinea pigs [53] and of Echidna.[54] Kolmer [52] also found a few smooth and striated muscle fibers attached to the wall of the ductus reuniens in another 5-month-old embryo. He was unable to explain their presence.

Occasionally groups of ganglionic cells are seen between the fibers of the cochlear nerve, either within the internal auditory meatus or within the lamina spiralis ossea (Alexander [35a]).

Even more extensive malformations do not necessarily impair the hearing. Guild [55] observed a bilateral defect of the upper part of the bony septum between the scalae without any other malformations in a child 7 months of age. He explains it by postulating resorption of the mesodermal tissues beyond the normal limits during the stage of cavity formation of the scala tympani and vestibuli, with complete disappearance of portions of the connective tissues usually present when ossification begins. Similar changes were seen by Polvogt and Crowe [51] in patients with normal hearing before death. In other patients they found the following abnormalities: defect in the bony wall of the middle turn of the cochlea, with some fibers of the facial nerve actually running through a part of the spiral ligament and circumscribed defects of the osseous spiral lamina either in the form of a complete gap or with substitution of the bone by fibrous tissue. Slight variations in the position of an individual turn of the cochlea in relation to the modiolus are often seen; the osseous spiral lamina may leave the modiolus at a higher level than normal so that the scala vestibuli is much smaller than the scala tympani. In one case the cochlea had only two, in another case three, full turns, but this is, according to the author, of little importance for the hearing acuity of all tones, provided the actual length of the basilar membrane is within normal limits.

Brief mention only should be made of the differences in the arrangement of the perilymphatic tissue in the vestibule (Alexander [56]; Ruttin [13]). These, however, represent physiological variations.

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52. Kolmer, W.: Neue Erfahrungen am menschlichen Labyrinth (Ductus reuniens mit Nervenrudimenten und quergestreiften Muskeln, Innervation, Glykogen, Verschwinden des grossen Wulstes in der Embryogenese), Arch. Ohren- Nasen- u. Kehlkopfh. **114**:225, 1926.

53. Alexander, G.: Über Entwicklung und Bau der pars inferior labyrinthi der höheren Säugethiere: Ein Beitrag zur Morphologie des Ohrlabyrinthes, Denkschr. Akad. Wiss. Math.-naturw. **70**:429, 1901.

54. Alexander, G.: Zur Entwicklungsgeschichte und Anatomie des inneren Gehörorganes der Monotremen, Zentralbl. Physiol. **17**:495, 1903.

55. Guild, S. R.: Case of Bilateral Scala Communis Cochlae Uncomplicated by Other Defects: An Embryological Interpretation of This and Associated Anomalies, Anat. Rec. **42**:19, 1929.

56. Alexander, G.: Zur Kenntnis der Anatomie, der Varietäten und der physiologischen und klinischen Bedeutung des perilymphatischen Gewebes, Ztschr. Hals- Nasen- u. Ohrenh. **3**:167, 1922.

OSSEOUS CAPSULE

The development of the osseous capsule depends upon the formation of the membranous labyrinth. Therefore changes in the latter cause changes in the configuration of the capsule. In the lateral wall of the labyrinthine capsule, which participates in the formation of the medial wall of the tympanic cavity, one finds, as a matter of course, certain anomalies, such as defects in the niches of the windows, in congenital malformations of the middle ear.

In rare instances the periosteal capsule is underdeveloped and the superior and posterior vertical canals are in a more superficial position. The eminentia arcuata becomes more prominent, and a prominentia canalis semicircularis posterioris is formed, the subarcuate fossa remaining very deep (Turkewitsch [57]). Turkewitsch described a case in which there were also some dehiscences in the bony walls of the two vertical semicircular canals.

Finally the varieties in the formation of the subarcuate fossa must be noted. In newborn children this fossa is very deep and contains a fold of the dura mater. During the first months of postembryonic life periosteal bony bridges develop and gradually fill the fossa (Rainer [58]). Residua of the subarcuate fossa, such as small grooves or short canals, are frequently found. In very rare cases infection can pass from the middle ear to the endocranium by this route if ossification is defective.

The ossification of the enchondral capsule proceeds from 14 different centers and at birth is practically finished (Bast [59]). Remnants of cartilage may, however, persist for various periods of fetal and postfetal life in several regions.

The best known of these regions is the fissula ante fenestram (Siebenmann [37]). It contains loose connective tissue at the vestibular end and dense connective tissue in the tympanic part. The formation of the fissular tissue is brought about by a dedifferentiation of the precartilage of the labyrinthine capsule in early embryonic stages (Cauldwell and Anson [60]). In later embryonic stages the ossification centers 1 and 3 of Bast [59] approach the fissular region from above and below and gradually reduce the cartilage to a stripe encasing the connective tissue of the fissula itself. In fetuses of about 23 weeks the cartilage is, according to Bast and Anson,[3] temporarily completely replaced by the extending bone. In the later fetal stages a varying amount of cartilage is deposited on the surface of the bone which borders the fissula. This secondary cartilage may persist throughout life or may gradually be transformed into bone. This bone shows a more or less completely lamellar structure. In addition to this bone, web-like fibril bone may be formed, having no relationship to the cartilage (Mayer [61]) within the fibrous tissue of the anterior part of the fissula.

57. Turkewitsch, B. G.: Oberflächliche Lage der knöchernen-Labyrinthe in den Schläfenbeinpyramiden ausgewachsener Menschenschädel, Frankfurt. Ztschr. Path. **46**:274, 1933.

58. Rainer, A.: Die Verknöcherung der Fossa subarcuata unter besonderer Berücksichtigung des knöchernen Feinbaues, Ztschr. Hals- Nasen- u. Ohrenh. **41**:446, 1937.

59. Bast, T. H.: Ossification of the Otic Capsule in Human Fetuses, Contrib. Embryol. (No. 121) **21**:53, 1930.

60. Cauldwell, E. W., and Anson, B. J.: Stapes, Fissula Ante Fenestram and Associated Structures in Man, from Embryos 6.7 to 50 mm. in Length, Arch. Otolaryng. **36**:891, 1942.

61. Mayer, O.: Untersuchungen über die Otosklerose, Hölder, Vienna and Leipzig, 1917.

Occasionally in young specimens the fissula is much larger than usual. Usually in these cases masses of abnormal cartilage develop from the secondary cartilage covering the bone on either side of the fissula (Bast and Anson[3]). Two types of such cartilage have been noted by these authors. One is local and self-limiting and usually does not obliterate the fissula; the other is neoplastic. It may not only obliterate the fissula but also extend into the surrounding marrow spaces and even cause destruction of the intervening bony trabeculae. The formation of these cartilaginous masses could be interpreted as an attempt at reducing the space of too wide fistulas. At later embryonic stages and in postfetal life these cartilaginous masses undergo ossification. As already stressed by Mayer,[61] the ossification always follows the usual pattern of the ossification of skeletal cartilage.

Masses of residual cartilage have in some instances also been observed at some distance from the fissula (Mayer).

The concept that the cartilage remnants in the fissular region show a relationship to the otosclerotic foci developing in this area was first expressed by Siebenmann[62] and later by Manasse[63] and Schoetz.[64] It was, however, rejected by Mayer,[61] who showed that the otosclerotic foci in the fissular region orignate in the periosteal part, where no cartilage remnants are found. He furthermore demonstrated that the ossification of the cartilage in the fissular region follows the regular pattern and that the resulting bone is histologically clearly distinct from the newly formed otosclerotic bone. This is particularly evident where ossifying cartilage and young otosclerotic foci are present in the same specimen. He also pointed out that no cartilage remnants are seen in the other areas of predilection for otosclerotic foci, such as the round-window region or the internal auditory meatus. The ideas of Manasse and Schoetz were revived by Guggenheim[65] and lately by Bast and Anson.[3] The latter two authors were able to show that cartilage remnants are found not only in the fissular region but also in six other areas. This could explain at least some of the other locations of the otosclerotic foci. Bast and Anson assume that the ossification of the residual cartilages may follow an atypical pattern and result in the formation of an atypical and unstable "gnarly" bone. Later attempts at rebuilding this unstable bone could produce otosclerotic foci. Del Bo (1950)[65a] comes to similar conclusions but Guild[66] disagrees with Bast and Anson for two principal reasons. Otosclerosis, histologically undistinguishable from that which occurs in the area of predilection, can and often does originate in parts of the otic capsule far removed from the fissula ante fenestram, and at least some of the otosclerotic

62. Siebenmann, F.: Multiple Spongiosierung der Labyrinthkapsel als Sektionsbefund bei einem Falle von progressiver Schwerhörigkeit, Ztschr. Ohrenh. **34**:366, 1899.

63. Manasse, P.: Über Ossifikationsanomalien im menschlichen Felsenbein und ihre Beziehungen zur sogenannten Otosklerose, Arch. Ohren- Nasen- u. Kehlkopfh. **95**:145, 1914.

64. Schoetz, W.: Gibt es eine kongenitale örtliche Disposition zur Bildung otosklerotischer Knochenherde? Arch. Ohren- Nasen- u. Kehlkofh. **95**:239, 1914.

65. Guggenheim, L. K.: Otosclerosis, St. Louis, The Author, 1935.

65a Del Bo, M.: Morfogenesi et morfologia della fissula ante fenestram nella capsula labirintica umana, Arch. ital. otol. **41**:403, 1950.

66. Guild, S. R.: Symposium on Histology and Pathogenesis of Otosclerosis: Incidence, Location and Extent of Otosclerotic Lesions, Arch. Otolaryng. **52**:848, 1950.

areas anterior to the oval window are, when still of small size, not in contact with any portion of the fissula ante fenestram.

Cartilage remnants in the fossula post fenestram (Siebenmann [37]) were first seen by Mayer.[61] They occur in about 5% of the cases and might partially ossify (Bast [67]). Within the fissular connective tissue, formation of web-like fibril bone might also occur, again without any relationship to cartilage remnants (Mayer [61]).

Cartilage remnants in the posteroinferior portion of the cochlear capsule (infracochlear region) are derived by Bast and Anson [3] from a bar of cartilage which extends from the occipital cartilage to the base of the cartilaginous cochlear capsule in fetuses of two and a half to four months. The base of the bar lies in the position of the future bony spur of the occipital bone which later forms the medial wall of the jugular fossa. In the course of further development the perichondral bone of the otic capsule surrounds the distal end of this cartilage and the latter undergoes enchondral ossification, but part of it may remain unchanged until birth. Shortly after birth the cartilage ossifies completely, but even after ossification it can be distinguished from the surrounding bone by its different structure.

In rare instances, cartilage remnants have also been seen in other parts of the cochlear capsule (Altmann [68]). A focus completely surrounded by a thin layer of perichondrium was seen in the upper wall of the internal auditory meatus in a 2-day-old child at the point where ossification centers 5 and 7 of Bast [59] unite. In a 6-month-old fetus with bilateral congenital atresia a mass of residual cartilage was found on one side in the upper wall of the cochlear capsule somewhat lateral to the fundus of the internal auditory meatus and on the other side in a somewhat more dorsolateral position, approximately at the site of union of the centers 3, 7, 11, 12, and 13 of Bast.[59]

Finally, mention must be made of the cartilage in the septum between the basal and middle turn, which never completely ossifies.

Isolated foci of cartilage in the canalicular region are rather frequent. They were present in 65% of the late fetuses and in infants up to three years examined by Bast and Anson.[3] For the most part they are located lateral to the subarcuate fossa, but there is no constant site of occurrence. Sometimes they are found below the ampulla of the posterior vertical canal (Habermann [69]), at the point where the ossification centers 2 and 4 of Bast [59] unite.

The cartilage of the otic capsule as a rule ceases to grow peripherally after ossification begins. In the region lateral to the facial canal and in front of (anterior to) the posterior and lateral canal, the expansion of the cartilage keeps ahead of the ossifying process until the capsular cartilage meets the squamous plate. Normally this cartilage is ossified at the time of birth, with the exception of the border. Residual cartilages in the region beneath the petrosquamous fissure were found by Bast and Anson [3] in 33% of full term fetuses and 29% of infants.

Similar growth processes also take place in the small part of the cartilaginous capsule situated along the basal and posterior margin of the cochlear round window

67. Bast, T. H.: Development of the Otic Capsule: The Fossula Post Fenestram, Arch. Otolaryng. **27**:402, 1938.

68. Altmann, F.: Zur Kenntnis der sogenannten persistierenden Knorpelherde im Bereiche der knöchernen Labyrinthkapsel, Arch. Ohren- Nasen- u. Kehlkopfh. **132**:297, 1932.

69. Habermann, J.: Über Erkrankungen des Felsentheiles und des Ohrlabyrinthes infolge der akuten eitrigen Mittelohrentzündung, Arch. Ohren- Nasen- u. Kehlkopfh. **42**:128, 1897.

after the remainder of the capsule has ossified (Bast and Anson [3]). This cartilage ossifies late but no residual cartilage has been observed at this site in late stages.

The ossification of the styloid cartilage in fetuses proceeds from the tip upward; the base which later fuses with the petrous bone remains cartilaginous until after birth. Ossification of the entire cartilage is generally completed during the first years of postnatal life. In a case mentioned by Bast and Anson a small mass of cartilage was still present in a 6-year-old child. Altmann [88] found in a man of 82 years (Case 7) a small focus of cartilage near the upper end of the styloid process, covered with a thin layer of perichondrium and without connection to the surrounding bone.

FOREIGN BODIES IN AIR AND FOOD PASSAGES

A Clinical Observation in Taiwan

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COMPARATIVE surveys of statistics relating to foreign bodies in the air and food passages are of great interest, and, when considered in relation to the geographical areas represented, may be of considerable ethnological importance. The object of this paper is twofold: first, to present a series of consecutive cases of foreign bodies dealt with between 1946 and 1950 at the National Taiwan University Hospital, and second, to compare the statistical aspects of this series of cases with those of other authors.

Our series of consecutive cases consists of 53 cases of esophageal foreign bodies and 17 of foreign bodies in the air passages.[1] The esophageal foreign bodies constitute 34.4% of all esophageal conditions seen in our department during the period from 1946 to 1950, but only 0.28% of all cases in which treatment was given during the same period. This incidence is smaller than that of C. Chang, who collected a series of cases at the Taihoku Red Cross Hospital and the Taihoku Imperial University Hospital, and less than that reported by other authors.

Foreign bodies in the air passages constituted 12.2% of the entire foreign body series, but only 0.09% of all of the cases in which treatment was given. Although this incidence is far less than that at the Jackson Bronchoscopic Clinic in Philadelphia,[2] and that at Osaka and Kyushu Universities, it is greater than the recent incidence reported by others. There has been a general increase in foreign bodies in the air passages in Taiwan in recent years.

Among the esophageal foreign bodies, coins were found in 13 cases (24.5%), an incidence somewhat smaller than that reported by other authors. This is apparently due to the fact that few coins were in circulation in Taiwan (Formosa) before and after the last war, until 1950. Since 1950, there has been an increase in the number of coins found as esophageal foreign bodies. All the patients were children under the age of 5, except two, one 7 and one 9 years of age.

Twenty-six of the esophageal foreign bodies (49.0%) were bones. More than half of these (15 out of 26) were bones of domestic animals (chicken, 6; duck, 4; pork, 3, and goose, 2), and most of them were of the double-pointed or spicular

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1. Cases in which the foreign body lodged in the hypopharynx or had already passed into the stomach at the time of the initial x-ray examination have been excluded from the series analyzed in this paper.

2. Jackson, C., and Jackson, C. L.: Diseases of the Air and Food Passages of Foreign Body Origin, Philadelphia, W. B. Saunders Company, 1936; Bronchoesophagology, Philadelphia, W. B. Saunders Company, 1950; personal communication to the authors.

TABLE 1.—*Foreign Bodies in the Food Passages*

Author and Reference	Institution or Locality	Observation Period	Foreign Bodies								AAO.	Mort.	Comment
			Co.	DAB.	Fb.	Dt.	PNH.	Fd.	Misc.	Total			
Hung and Lin.....	National Taiwan Univ. Hosp.	1946-1950 5 yr.	13	15	11	3	2	5	4	53	10.6	0	.....
Hung and Lin.....	Taihoku Imperial Univ. Hosp.	1940-1945 6 yr.	5	21	9	2	1	4	3	45	7.5	3 6.66%	8 Japanese
Chang: Personal communication to author	Taihoku Red Cross Hosp. and Taihoku Imperial Univ. Hosp.	1933/10-1939 6 yr. 3 mo.	47	20	3	7	..	..	5	82	13.7	3 3.65%	8 Japanese
Hayata: Memorials of Otolaryng. Clinic of Taihoku Med. School, 1933.....	Taihoku Red Cross Hosp.	1924-1933/9 9 yr. 9 mo.	27	20	20	4	..	..	2	73	7.3	?	19 Japanese
Clerf: Surg., Gynec. & Obst. **70**:328, 1940....	Jefferson Med. College	.....	89	147	..	16	65	..	220	537	....	4 0.75%	Hypopharynx, 48 cases; stomach, 32 cases
Norris: Ann. Otol. Rhin. & Laryng. **57**: 1049, 1948.....	Temple Univ. Hosp.	1941-1946 6 yr.	40	52	17	5	33	24	24	195	32.5	1 0.51%	Hypopharynx, 40 cases; stomach, 4 cases
Gittins: Ann. Otol. Rhin. & Laryng. **40**: 181, 1931.....	Sioux City, Iowa	.....	6	..	9	..	7	5	12	39	....	..	.....
Hager: Ztschr. Hals- Nasen- u. Ohrenh. **41**: 812, 1937.....	V. Eicken Clinic, Berlin	1926-1935 10 yr.	90	245	50	75	29	46	43	578	57.8	15 2.59%	.....
Schlemmer: Arch. klin. Chir. **114**:37, 1920.....	Hajek Clinic, Vienna	1909/7-1919/6 10 yr.	29	215	22	61	..	106	96	529	52.9	15 2.83%	.....
Matheson: J. Laryng. & Otol. **63**:435, 1949..	St. Giles' Hosp., London	1936/7-1949/2 12 yr. 8 mo.	100	151	157	29	20	57	88	602	47.5	2 0.33%	.....
Alacantara & Ayuyao: J. Philippine I. M. A. **52**:31, 1932	Manila, P. I.	.....	15	..	..	..	3	5	2	25	....	..	.....
Liu: National M. J. China **14**: Dec., 1928....	Hsieh-ho Otolaryng. Clinic, Peiping	1921-1928 8 yr.	7	..	1	5	5	1	1	20	2.5	1 5.0%	.....
Matsui: Oto-rhino-laryng. **15**:780, 1942.....	Manchurian Univ. Hosp.	1915-1940/5 25 yr. 5 mo.	41	..	20	16	..	..	44	121	4.7	..	59 Japanese; 59 Manchurian; 3 misc.
Miyoshi & Umezu: Cited in Matsui's report.	Keijo Univ. Hosp.	1928-1937 10 yr.	101	..	14	..	..	..	49	164	16.4	..	.....
Mukagasa: Oto-rhino-laryng. **9**:68, 1936.....	Moppo City, Korea	1931/4-1935/9 4 yr. 6 mo.	3	..	18	..	..	..	19	40	8.8	..	17 Japanese; 23 Korean
Kanabayashi: Oto-rhino-laryng. **12**:341, 1939.	Keijo Provinc. Hosp.	1934/3-1937/2 4 yr.	23	..	2	2	..	..	11	38	9.5	..	.....
Sasaki: in Kubo: Handbuch der Oto-Rhino-Laryngologie, Fukuoka, Japan, 1933, Vol. 10, Pt. 1, p. 93.....	All Japan	1908-1931 23 yr.	130	9*	115	141	14	20	79	508	22.1	28 5.51%	All cases in Japanese literature, excluding those observed at Kubo's Clinic
Hane: Chiryo Shoho (Japan) **13**:1573, 1932..	Kagoshima City, Japan	13 yr.	83	28*	25	11	..	..	19	166	12.7	1 0.60%	.....

Tomonaga: Nagasaki igakkwai zassi **13**:1139, 1935	Nagasaki Med. College	1912-1934 22 yr.	51	3	26	2	..	..	14	96	4.4	8 8.33%	.....
Tsuruno: Kumamoto igakkwai zassi **14**:3, 1938	Kumamoto Med. College	1927-1936 10 yr.	58	..	10	2	..	..	17	87	8.7	..	.....
Hanamure: Ztschr. Oto-Rhino-Laryng. **48**: 733, 1942	Kumamoto Med. College	1937-1941 5 yr.	29	..	10	4	1	..	5	49	9.8	..	.....
Sasaki & Kubo: Otolaryngology **21**:5, 1949..	Kyushu Imperial Univ. Hosp.	1936-1945 10 yr.	74	9	33	11	..	..	36	163	16.3	7 4.28%	.....
Kubo: Memorial of Otolaryng. Department of Kyushu Imperial Univ., 1933 and 1938..	Kyushu Imperial Univ. Hosp.	1904-1923 17 yr.	127	3	65	62	9	15	42	323	19.0	..	.....
		1927-1931 5 yr.	96	..	24	10	..	..	12	142	30.1	..	.....
		1932-1936 5 yr.	74	2	21	..	..	..	55	159			
Murata: Oto-rhino-laryng. **13**:867, 1940.....	Kobe & Osaka Railway Hosp.	.....	14	1	1	2	..	..	7	25	....	..	.....
Kubo: Osaka iji-shinshi **3**:1510, 1932.....	Osaka Imperial Univ. Hosp.	1924/7-1932/7 8 yr.	120	..	12	8	..	..	6	146	18.3	..	.....
Furukawa: Tokyo iji-shinshi No. 2951, 1935..	Osaka Imperial Univ. Hosp.	1932-1935 3 yr. 6 mo.	100	..	14	7	..	..	24	145	41.4	..	.....
Tsuchiya: cited in Oto-rhino-laryng. **15**:780, 1942	Osaka Imperial Univ. Hosp.	1935-1938 4 yr.	130	..	14	3	..	..	44	191	47.8	..	.....
Tatsumi Osaka iji-shinshi **23**:1437, 1924.....	Osaka Med. College	1912-1924 12 yr.	61	3	22	29	3	7	9	135	11.3	..	.....
Maruoka: Rinsho nippon igaku, No. 4 & No. 5, 1936.....	Kyoto Furitsu Med. College	1929-1934 6 yr.	30	..	1	7	..	..	9	47	7.8	..	.....
Oyama: Osaka Koto Igaku Senmon Gakko Kaishi **1**:411, 1932.....	Osaka Red Cross Hosp.	1923-1932 10 yr.	73	..	3	13	..	..	15	104	10.4	0 0.96%	.....
Iwata: Ztschr. Oto-Rhino-Laryng. **41**:616, 1935	Nagoya Imperial Univ. Hosp.	1915-1934/11 20 yr.	181	1	19	30	6	4	38	279	13.5	..	.....
Tanemura & Nakasato: Oto-rhino-laryng. **7**: 366, 1934.....	Kanazawa Med. College	1927/2-1933/9 7 yr.	38	..	8	6	..	..	11	63	9.0	3 4.76%	.....
Yamaguchi: Chiryo Shoho **3**:142, 1922.....	Nagano City Red Cross Hosp.	1913/9-1922/11 8 yr. 8 mo.	20	..	1	13	..	..	7	41	5.0	..	.....
Watabe: Ztschr. Oto-Rhino-Laryng. **48**:629, 1941	Kanazawa Med. College	1933/10-1940/7 7 yr.	47	..	13	10	3	..	16	89	12.7	..	.....
Kosokabe: Hokkaido igakkwai zassi **10**:1427, 1932	Hokkaido Imperial Univ.	1922/9-1932/6 10 yr.	26	..	6	3	2	..	6	43	4.3	1 2.32%	.....

* Chicken.

Key to abbreviations: Co., coins; DAB., domestic animal bones; Fb., fishbones; Dt., dentures; PNH., pins, needles and hardware; Fd., foods; Misc., miscellaneous; AAO., average annual occurrence; Mort., mortality (both number of fatal cases and percentage).

TABLE 2.—*Foreign Bodies in the Air Passages*

Author and Reference	Institution or Locality	Observation Period	Foreign Bodies														
			Vegetal				Animal			Mineral							
			Pn.	Ns.	Wm.	M.	L.	Fb.	M.	NN.	Dc.	M.	M.	Total	AAO.	Mort.	Comment
Hung & Lin.....	National Taiwan Univ. Hosp	1946-1950 5 yr.	7	1	..	1	1	4	..	2	..	1	..	17	3.4	0	Larynx, 5 cases; 1 aborigine
Hung & Lin.....	Taihoku Imperial Univ. Hosp.	1938-1945 8 yr.	6	..	2	4	2	1	1	..	1	..	..	17	2.1	2 11.7%	Larynx, 2 cases; 4 Japanese; 4 aborigines
Hayata: Memorials of Otolaryng. Clinic of Taihoku Med. School, 1933	Taihoku Red Cross Hosp.	1924-1933/9 9 yr. 9 mo.	3	1	1	2	1	5	..	..	..	..	2	15	1.5	?	Larynx, 6 cases; 2 Japanese
Clerf: Surg., Gynec. & Obst. **70:** 328, 1940....	Jefferson Med. College	.....	115	15	12	16	..	..	..	21	..	..	234	413	....	12 2.9%	Larynx, 19 cases
Norris: Ann. Otol., Rhin. & Laryng. **57:** 1049, 1948	Temple Univ. Hosp.	1941-1946 6 yr.	17	1	3	4	..	2	..	12	..	16	..	55	9.2	1 1.81%	Larynx, 2 cases
Gittins: Ann. Otol., Rhin. & Laryng. **40:** 181, 1931	Sioux City, Iowa	.....	6	2	3	15	..	1	..	2	..	..	13	42	....	..	.....
Oppikofer: Schweiz. med. Wchnschr. **65:** 673, 1935	Basel, Switzerland	1896-1935 40 yr.	..	10	..	16	..	3	..	..	..	..	11	40	1.0	4 10.0%	.....
Alexandrowskaja: Ztschr. Hals-, Nasen- u. Ohrenh. **22:** 306, 1928	Moscow, Russia	.....	..	..	..	29	..	5	..	2	..	..	4	40	....	1 2.5%	Larynx, 4 cases
Liu: National M. J. China **14:** Dec., 1928.....	Hsieh-ho Otolaryng. Clinic, Peiping	1921-1928 8 yr.	2	..	2	2	..	..	..	1	3	..	..	10	1.3	..	Larynx, 2 cases
Matsui: Oto-rhino-laryng. **13:** 872, 1940.....	Manchurian Univ. Hosp.	.....	6	5	12	4	..	1	1	..	..	..	9	38	....	1 2.6%	.....
Habu & Fukushima: Oto-rhino-laryng. **7:** 128, 1934	Keijo Imperial Univ. Hosp.	5 yr.	1	..	..	1	..	7	..	5	..	2	..	16	3.2	1 6.2%	Larynx, 10 cases; 15 Koreans; 1 Japanese

Yokoi & Amizuka: Grenzgebiet **10:** 1738, 1936	All Japan	1894-1935 42 yr.	21	67	68	40	5	30	..	20	..	..	115	366	8.7	36 9.8%	.....
Goto & Nakano: Ztschr. Oto-Rhino-Laryng. **41:** 507, 1935	All Japan	1927-1933 7 yr.	..	39	20	15	2* 1†	5	4	5	..	..	26	117	16.7	11 8.4%	.....
Saino: Nagasaki igakkwai zassi **17:** 756, 1939	Nagasaki Med. College	1913-1935/5 22 yr.	4	2	3	..	..	2	1	2	..	..	6	20	0.9	..	.....
Kaneko: Oto-rhino-laryng. **9:** 474, 1936.....	Kumamoto Med. College	1926-1935 10 yr.	1	4	2	2	..	2	..	..	..	2	..	13	1.3	..	.....
Ohashi: Ztschr. Oto-Rhino-Laryng. **48:** 337, 1942	Kumamoto Med. College	1935-1941 7 yr.	..	4	..	8	..	3	..	..	..	6	..	21	3.0	2 9.5%	.....
Hane: Chiryo Shoho **14:** 160, 1933.....	Kagoshima City, Japan	13 yr.	4	6	30	10	2	5	6	..	..	1	5	69	5.3	?	.....
Kubo: Memorial of Otolaryng. Department of Kyushu Imperial Univ. Hosp., 1938	Kyushu Imperial Univ. Hosp.	1932-1936 5 yr.	3	8	2	4	..	..	..	4	..	..	2	23	4.6	..	.....
Sasaki & Kubo: Otolaryngology **21:** 5, 1949	Kyushu Imperial Univ. Hosp.	1936-1945 10 yr.	4	20	1	5	..	12	1	8	1	10	3	65	6.5	2 3.1%	Larynx, 20 cases
Furukawa: Tokyo ijishinshi, No. 2956, p. 2962, 1935	Osaka Imperial Univ. Hosp.	1932-1935/8 3 yr. 8 mo.	4	3	..	..	..	..	..	5	..	2	1	15	4.0	2 13.3%	.....
Yamakawa: Shindan Chiryo, Supp. 16, 1940	Osaka Imperial Univ. Hosp.	1936-1939/5 3 yr. 6 mo.	..	8	..	2	..	5	2	4	..	..	10	31	8.8	3 9.6%	.....
Iwata: Ztschr. Oto-Rhino-Laryng. **41:** 616, 1935	Nagoya Imperial Univ. Hosp.	1915-1934/11 19 yr. 11 mo.	5	8	6	4	..	4	..	..	..	5	..	32	1.6	3 9.3%	Larynx, 9 cases
Hagino & Tanaka: Aichi igakkwai zassi **34:** 101, 1928	Aichi Med. College, Nagoya	1896-1926 31 yr.	..	22	8	10	1 5*	5	2	6	..	..	37	96	3.0	9.6%	.....
Kosokabe: Hokkaido igakkwai zassi **10:** 1427, 1932	Hokkaido Imperial Univ. Hosp.	1922/9-1932/6 10 yr.	..	3	..	3	..	..	..	..	..	..	1	7	0.7	..	.....

* Fishes.

† Worm.

Key to abbreviations: Pn., peanuts; Ns., other nuts, peas, and seeds; Wm., watermelon seeds; M., miscellaneous; L., leech; Fb., fishbones; NN., needles and nails; Dc., discs; AAO., average annual occurrence; Mort., mortality (both number of fatal cases and percentage).

TABLE 3.—*Summary of Cases*

Case No.	Name	Age, Yr.	Sex	Admission	Foreign Body	Location	Retention Hr.	Comment
1	P. W.	36	M	10/28/46	Badge, brass	Esophagus below cricopharyngeus	48	Round, diameter 3.0 cm.; swallowed while patient was intoxicated
2	M. H.	5	F	2/17/48	Coin, copper, 1 sen	Esophagus below cricopharyngeus	240	Diameter 2.1 cm.; unsuccessful attempt at removal prior to admission
3	C. C.	4	M	12/ 7/49	Coin, copper	Esophagus below cricopharyngeus	168	
4	C. H.	6	M	12/ 3/49	Coin, copper, 10 cents	Esophagus at crossing of left bronchus	1	Diameter 2.0 cm.
5	C. H.	3	F	4/10/50	Coin, copper, 10 cents	Esophagus just below cricopharyngeus	1	
6	H. W.	5	M	5/24/50	Coin, copper, 10 cents	Esophagus 18 cm. from upper teeth	72	
7	A. L.	3	F	5/28/50	Coin, copper, 10 cents	Esophagus at hiatus esophageus	168	
8	S. C.	9	M	2/28/50	Coin, silver, 50 sen	Esophagus 18 cm. from upper teeth	2	Diameter 2.2 cm.
9	M. C.	7	F	6/22/50	Coin, copper, 10 cents	Esophagus at hiatus esophageus	2	
10	K. T.	3	F	7/26/50	Coin, copper, 10 cents	Esophagus 14 cm. from upper teeth	48	
11	T. K.	4	M	8/26/50	Coin, copper, 10 cents	Esophagus 12 cm. from upper teeth	168	
12	C. C.	4	M	9/19/50	Coin, copper, 10 cents	Esophagus below cricopharyngeus	2	Coin went down to the stomach during endoscopy
13	S. M.	4	F	10/30/50	Coin, copper, 10 cents	Esophagus 17 cm. from upper teeth	48	
14	H. C.	3	M	11/20/50	Coin, copper, 10 cents	Esophagus below cricopharyngeus	4	
15	H. L.	37	M	7/31/50	Stopper of bottle, zinc	Esophagus 18 cm. from upper teeth	16	Diameter 3.0 cm.; swallowed while opening bottle with teeth; trauma in esophageal wall
16	Y. H.	60	M	6/ 5/46	Duck bone and meat	Esophagus 19 cm. from upper teeth	24	3 cm. long, spicular
17	C. H.	67	F	3/14/47	Chicken bone	Esophagus 18 cm. from upper teeth	72	Spicular; moderate injury of esophageal wall
18	M. C.	21	F	6/ 7/47	Chicken bone	Esophagus below cricopharyngeus	48	Irregularly shaped; marked edematous swelling above site of lodgment; incision disclosed retropharyngeal abscess; rapid recovery after incision and penicillin injection
19	P. K.	64	M	11/16/48	Chicken bone and meat	Esophagus 20 cm. from upper teeth	12	Two pieces of spicular bone
20	K. W.	32	M	2/19/48	Chicken bone	Esophagus 17 cm. from upper teeth	3	
21	C. H.	68	F	4/14/49	Goose bone	Esophagus 20 cm. from upper teeth	24	Unsuccessful attempt at removal owing to moderate bleeding after admission
22	P. H.	26	M	2/28/50	Chicken bone and meat	Esophagus 18 cm. from upper teeth	2	Triangular; periesophageal abscess after removal of bone, drainage into esophagus, healed
23	M. P.	17	M	8/15/50	Pork bone	Esophagus 19 cm. from upper teeth	120	Damage of esophageal wall
24	C. H.	27	M	10/26/50	Pork bone	Esophagus 19 cm. from upper teeth	216	Moderate trauma of esophageal wall

25	T. H.	21	F	7/ 9/46	Duck bone	Esophagus 33 cm. from upper teeth	168	Trauma of esophageal wall
26	T. Y.	8	M	7/25/46	Duck bone	Esophagus 16 cm. from upper teeth	96	Slight trauma
27	P. C.	35	M	8/28/46	Pork bone and meat	Esophagus at hiatus esophageus	24	Slight trauma
28	S. L.	59	M	9/30/47	Duck bone	Esophagus 18 cm. from upper teeth	72	Periesophageal abscess, drainage into esophagus, healed 5 days after penicillin injection
29	Y. Y.	48	F	4/30/47	Chicken bone	Esophagus 23 cm. from upper teeth	72	Advanced periesophageal abscess; external drainage; healing 32 days after incision and administration of penicillin
30	M. H.	12	F	12/10/47	Goose bone	Esophagus	120	Periesophagitis with chill, fever; 3 days after penicillin injection, recovered promptly
31	H. C.	83	M	9/ 1/47	Bolus of chicken meat	Esophagus 20 cm. from upper teeth	48	
32	H. C.	33	F	4/ 1/46	Chicken meat	Esophagus 20 cm. from upper teeth	72	
33	T. C.	31	F	10/ 3/47	Meat and other food	Esophagus 19 cm. from upper teeth	96	Inflammatory swelling near site of lodgment
34	C. Y.	60	M	4/20/46	Fishbone	Esophagus 23 cm. from upper teeth	12	2.4 cm. long, spicular
35	C. F.	31	F	4/28/47	Fishbone	Esophagus below cricopharyngeus	1	Flat oval bone
36	C. L.	58	M	11/29/47	Fishbone	Esophagus at hiatus esophageus	96	Flat triangular bone; cervical swelling with slight fever on admission; foul pus evacuated after removal of foreign body; periesophageal abscess healed without external drainage but with penicillin injection; hospitalization 3 days
37	C. K.	35	M	8/ 5/48	Fishbone	Esophagus 17 cm. from upper teeth	120	1 cm. long, sharp pointed vertebra; advanced periesophageal abscess; considerable amount of foul pus drained by external esophagotomy; foreign body removed from wound; topical irrigation with penicillin solution brought satisfactory result; cured 20 days after operation
38	K. H.	23	F	1/17/49	Fishbone	Esophagus 19 cm. from upper teeth	72	Spicular bone
39	T. R.	7	M	10/17/49	Fishbone	Esophagus, upper orifice	96	T-shaped; one point embedded in the left piriform sinus; some granulation in vicinity of foreign body lodgment; moderate quantity of purulent pus aspirated (periesophageal abscess); systemic use of penicillin resulted in rapid recovery
40	T. T.	62	F	7/30/50	Fishbone	Esophagus, upper orifice	96	Trauma of esophageal wall
41	F. K.	45	F	3/22/50	Fishbone	Esophagus 17 cm. from upper teeth	96	Spicular bone, surrounded by bleeding granulations; pus aspirated; systemic use of penicillin and streptomycin resulted in rapid healing
42	Y. C.	32	F	6/ 9/46	Fishbone and food	Esophagus	96	From 16 cm. to 20 cm. distant from upper teeth injured, bleeding with marked edematous swelling
43	F. W.	10	M	3/19/48	Fishbone	Esophagus 18 cm. from upper teeth	96	Marked cervical swelling, with moderate fever; external drainage; healing 15 days after incision (periesophageal abscess)
44	S. C.	58	M	1/23/48	Fishbone	Esophagus	48	20-25 cm. region granulated and bleeding; penicillin injection resulted in prompt recovery

TABLE 3.—*Summary of Cases*—Continued

Case No.	Name	Age, Yr.	Sex	Admission	Foreign Body	Location	Retention Hr.	Comment
45	C. Y.	27	M	4/21/46	Food	Esophagus 23 cm. from upper teeth	24	Slight damage of esophageal wall
46	Y. S.	26	M	7/ 8/47	Bamboo fragment	Esophagus 18 cm. from upper teeth	96	Severe pain with moderate bleeding and fever for 2 days; moderate edema and infiltration; cured 7 days after penicillin injection
47	Y. C.	77	F	3/ 1/49	Food	Esophagus 34 cm. from upper teeth	24	Cicatricial stenosis of esophagus since 50 years ago
48	I. T.	50	M	4/18/49	Food	Esophagus at crossing of left bronchus	48	Slight stagnation of food for 2 months; esophagoscopy revealed malignant tumor
49	L. K.	52	F	4/22/49	Needle	Esophagus, upper orifice	96	Attempted suicide; another foreign body (gold ring) went down into stomach
50	T. W.	34	M	6/20/46	Needle	Esophagus, upper orifice	48	Swallowed while eating
51	C. C.	57	F	5/17/46	Denture, vulcanite	Esophagus below cricopharyngeus	1	Unsuccessful extraction once prior to admission; cured
52	C. F.	52	M	6/25/47	Denture, vulcanite	Esophagus below cricopharyngeus	10	Moderate trauma of esophageal wall at 18 cm. depth; recovery after penicillin injection
53	Y. C.	48	M	11/ 6/49	Denture	Esophagus, upper orifice	1	Foreign body went down into stomach during endoscopy; 10 days thereafter passed by bowel without any complication
54	S. W.	8	M	7/ 2/49	Fishhook	Larynx, subglottic	3	Point embedded in posterior wall of larynx, head in subglottis toward anterior wall
55	L. K.	56	F	6/20/48	Needle	Larynx	96	Point in left arytenoid; patient an insane woman
56	J. T.	22	M	11/16/48	Fishbone	Laryngeal wall	24	2 cm. long
57	M. C.	28	M	10/31/46	Fishbone	Larynx, r. arytenoid	96	
58	A. C.	48	M	8/ 8/46	Rabbit bone	Larynx	24	2 cm. long
59	C. Y.	3½	F	12/18/46	Peanut, ½ kernel	Right main bronchus	96	Recovery
60	W. H.	1 11/12	F	10/20/46	Peanut kernel	Left lower bronchus	24	Unsuccessful endoscopy before admission; pyothorax developed after removal of foreign body; penicillin administration brought good result; hospitalization 15 days
61	H. O.	1½	M	5/ 2/47	Peanut kernel	Trachea	4	Uneventful recovery
62	H. T.	3	M	9/24/48	Peanut kernel	Trachea	168	Moderate pneumonia; recovery after penicillin administration
63	Y. C.	2	M	12/16/48	Peanut kernel	Left main bronchus	4	Recovery
64	T. T.	2	M	9/ 8/49	Peanut, ½ kernel	Trachea	24	Recovery
65	L. P.	3	F	11/28/50	Peanut kernel	Left lower bronchus	288	Unsuccessful endoscopy prior to admission; tracheotomy required for dyspnea on day after bronchoscopic removal; penicillin injection showed good effect on marked arachidic bronchitis
66	T. R.	5	M	2/27/49	Maize	Trachea	3	Recovery
67	T. L.	8	F	1/21/50	Olive stone, ½	Trachea, subglottic	4	Recovery
68	T. T.	17	F	7/ 5/47	Leech, living	Trachea, subglottic	500?	Patient drank at mountain stream 3 weeks before admission; bloody sputum for 5 days; after worm was anesthetized with cocaine solution, easy removal
69	C. T.	6	F	3/27/50	Fishbone, plate	Trachea, subglottic	72	
70	M. Y.	8	F	7/30/46	Phial, glass	Trachea	72	Repeated endoscopy necessary owing to smoothness, fragility, and transparency; removed piecemeal

variety. Chang has previously called attention to the prevalence of domestic animal bones as esophageal foreign bodies in Taiwan (25.6%). The corresponding figure in our series is 28.3%. This percentage is approximately the same as that reported by Norris, Clerf, and Matheson, but somewhat smaller than that of Hager or that of Schlemmer; it is noticeably larger than the incidence reported in the Far East.

In 11 cases (20.7%), the esophageal body was a fishbone. The incidence of this type of foreign body has increased in Taiwan since the war. This may perhaps be related to the temporary occupation by the Japanese, who included fish somewhat more commonly in their diet.

Advanced periesophagitis and periesophageal abscess were observed as a complication of esophageal foreign body in 10 cases (fishbone, 6; chicken bone, 2; duck

TABLE 4.—*Additional Cases, 1950 to March 31, 1951*

Case No.	Age, Yr.	Sex	Foreign Body	Location	Retention Hr.	Comment
1	4	M	Coin	Esophageal orifice	48	.....
2	4	F	Coin	Esophagus 14 cm. from upper teeth	..	Unsuccessful endoscopy prior to admission; recovery uneventful after removal
3	25	M	Chicken bone and meat	Esophagus 20 cm. from upper teeth	24	Recovery
4	61	M	Chicken bone, spicular	Esophagus 20 cm. from upper teeth	..	Advanced periesophagitis; recovery after removal and penicillin injection
5	31	F	Duck bone	Esophagus below cricopharyngeus	24	Uneventful recovery
6	59	M	Pork bone and meat	Upper orifice of esophagus	168	Advanced periesophageal abscess, drained in esophagus; recovery after systemic use of penicillin
7	60	M	Chicken bone	Esophagus 20 cm. below upper teeth	48	Periesophagitis; recovery
8	14	F	Fishbone	.....	216	Marked painful swelling in neck and posterior pharyngeal wall; external esophagotomy disclosed abscess cavity from retropharyngeal space to periesophageal spaces at cervical region; rapid recovery after incision, and local and systemic penicillin and streptomycin
9	42	M	Fishbone	Esophagus	2	Slight damage to esophageal wall just below cricopharyngeus; healing
10	24	F	Gold ring	Upper orifice of esophagus	24?	Passed by bowel next day
11	5	M	Pork	Trachea	..	Admitted at midnight with dyspnea; croupy cough; expectorated pork spontaneously during chest examination; recovery

bone, 1, and bamboo fragment, 1) and retropharyngeal abscess was observed in one case involving a chicken bone. Surgical drainage was required in the case of retropharyngeal abscess, and external drainage in three of the cases of periesophageal abscess. In the remainder, as well as in those with moderate injury of the esophageal wall, healing without complication followed systemic administration of pencillin or streptomycin. There were no fatal cases in the group involving eosphageal foreign bodies.

Of the 17 foreign bodies in the air passages, constituting 24.3% of the entire series, 5 were lodged in the larynx, 8 in the trachea, 1 in the right, and 1 in the left main bronchus, and 2 in the left lower lobe bronchus. As reported by others, vegetal foreign bodies were most frequently encountered (52.9%), and the majority of them were peanuts (7 out of 9 vegetal foreign bodies, or 77.7%). This incidence is the greatest in any reported series. Pneumonia, pyothorax, and arachidic bronchitis

were encountered, each in one case, but the severe clinical manifestations subsided rapidly after endoscopic removal of the foreign body and systemic administration of penicillin.

Foreign bodies of animal origin were encountered in the air passages in five cases; four of these foreign bodies were fishbones and the other was a living leech in the trachea of a 17-year-old native girl. The leech has been quite frequently encountered as a living foreign body in the airway (larynx, trachea, or nose) among the aborigines in mountain country. However, the incidence of this type of foreign body has greatly decreased because of more general awareness of its possible occurrence as a foreign body.

All foreign bodies were successfully removed by the peroral route. In one case, after removal of a small fragment of peanut from the left lower lobe bronchus, tracheotomy was required for inspiratory laryngeal obstruction following repeated procedures. No death occurred in the entire group.

Of the esophageal foreign bodies, 44.7% were first seen by us within 24 hours after the foreign body accident, and 71.0% were seen within the first three days. Of the foreign bodies in the air passages, 52.9% were seen within 24 hours. The average time the foreign bodies remained in the passage amounted to 3.9 days in the esophageal group, and 3.8 days in the other group. Formerly, the interval prior to the first visit was much greater; this suggests that medical advice is now sought at an earlier date and that removal is more promptly accomplished. In fact, severe injuries of the esophageal walls due to unskilled instrumentation or dangerous manipulations, or due to prolonged retention of the foreign bodies through ignorance of the patient, are much less frequently observed than in former years. In only four cases in the present series had an unsuccessful previous attempt to remove the foreign body been made. Both the patients and the physicians appear to be more aware of the danger of foreign bodies, and treatment based on superstition has now entirely disappeared.

Jackson [1] has stated that nearly 90% of the foreign body accidents are due to carelessness, and are therefore avoidable. The majority of our cases may likewise be attributed to carelessness in eating, in preparation of food, in putting inedible substances in the mouth, or in the swallowing by children of objects with which they are playing. Accordingly, the importance of the preventive aspect of the foreign body problem, including instruction to mothers and nurses, as well as to those who prepare food, is as evident in Taiwan as elsewhere.

SUMMARY AND CONCLUSIONS

There has been a recent increase in the incidence of foreign bodies in the air and food passages in Taiwan.

Of the esophageal foreign bodies, bones were the most frequent, with frequent complications such as periesophagitis or periesophageal abscess. Of the foreign bodies in the air passages, peanuts were most often observed.

Increased awareness of physicians and the general population as to the dangers of foreign bodies, along with better endoscopic technique and the use of antibiotics, has improved the prognosis in foreign body accidents.

Education of the general public and the medical profession, and proper instruction of those who care for children or prepare food, are the most important items in prevention of foreign body accidents.

RESEARCH IN OTOLOGY IN THE UNITED STATES IN 1952

DOUGLAS MACFARLAN, M.D.
PHILADELPHIA

There's an army that's never been listed,
That knows no color nor crest,
But broke in a thousand detachments
Is leading the road for the rest.—*Rudyard Kipling.*

THE POET in terse words has pictured for us that sizable group of our fellow scientists who, plodding along, for the most part unheralded and unsung, are giving us new ideas and new methods to apply clinically to our everyday problems.

One will, I think, be surprised at the nature and amount of research study under way. At least one can surmise that our specialty is not standing still. It will be noted that the bulk of the work is not of an academic nature and interest but has a definitely objective implication toward the practical solving of problems. Undoubtedly, in a listing such as that which follows, some workers and their studies have been overlooked. If so, I offer apologies and ask to be further informed.

It will be of some satisfaction to note that most of this research is in the hands of the medical profession and its institutions, being the work of individuals, of medical societies, or of medical schools. There have been and are "grants in aid," and there are the necessary activities of the government services in solving otological problems arising in the armed services. And now, with the growing interest in the effect of noise, industry is coming into the picture as an interested party. It is well that the American Academy has in a timely way recognized that the otological profession should take a key position in the study of noise from the angle of acoustic damage, degree of disability, prevention, and rehabilitation.

The listing which follows is in some cases largely a statement of the studies; enlargement of the topics and a more careful outline of objectives would make the reporting too voluminous. Yet names and addresses are added for the convenience of readers who may wish to inquire further. The results of these researches will undoubtedly be published in time.

One can read between the lines the trends in research, and as the decades succeed each other one will be able to see from such listings how otology changes and progresses.

JULIUS WINSTON, M.D., 5839 Chester Ave., Philadelphia 43.

Dr. Winston is completing a study of cats who had received streptomycin to the point of abolishing the vestibular responses to turning. The cochlear end-organ as well as the central nuclei will be studied in these animals.

With Dr. Alan Rubin, of the Hospital of the University of Pennsylvania, Philadelphia, Dr. Winston has studied the effects of menstruation on vestibular function.

HOWARD HOUSE, M.D., 1136 W. 6th St., Los Angeles.

Dr. House's present research is almost entirely on noise in industry. He is working with Dr. Douglas Wheeler under the auspices of the Conservation of Hearing Committee of the American Academy of Ophthalmology and Otolaryngology.

Dr. House is also working on the problem of congenital atresia of the ear canal and on the testing of bone conduction in cases in which the opposite eighth nerve has been destroyed. The latter study is concerned with the problem of masking.

KENNETH M. DAY, M.D., 121 University Place, Pittsburgh.

For the last 10 years Dr. Day has been doing clinical research on Ménière's disease, having analyzed between 300 and 400 cases with the primary purpose of working out the symptomatology and diagnosis.

Dr. Kenneth Stewart, of Dr. Day's staff at the University of Pittsburgh, has completed his master's thesis on the psychogalvanic skin response. The paper has not yet been published.

The audiology department is working on the problem of industrial noise, both from the angle of testing the noise levels in plants and from that of testing employees who work in various noise levels.

Dr. Day and his co-workers have been trying to get a chemical analysis of the fluid contents of secretory middle ears, with special reference to so-called "glue," or mucoid secretion. There is uncertainty as to whether this "glue" is a transudate or exudate. From protein content it would seem to be a transudate. If so, this means that the serum, which occurs with tubal block under certain conditions, will coagulate, resulting in the glue type of ear.

JULIUS LEMPERT, M.D., and DOROTHY WOLFF, M.D., Lempert Institute of Otology, 119 E. 74th St., New York City.

Research work is being continued on the microscopic pathology of the vestibular endolymphatic labyrinth, following up a paper read at the meeting of the American Otological Society at Toronto in 1952.

LEWIS FRANCIS MORRISON, M.D., 490 Post St., San Francisco.

Dr. Morrison reports his investigative work as the study of temporal bone pathology, as follows: (*a*) study of serial sections of normal and abnormal temporal bones; (*b*) study of serial sections of ossicles removed during fenestration operations, and (*c*) attempts to explain the phenomena associated with osteogenesis.

HAROLD WESTLAKE, Ph.D., Northwestern University, president of the American Speech and Hearing Association.

Dr. Westlake reports the tentative draft of a "Code of Ethics for the Speech and Hearing Association." The code is a general professional guide for all members in the field both in audiology and in speech correction; it does not relate specifically to hearing clinics.

NORTON CANFIELD, M.D., 175 St. Ronan Street, New Haven 11, Conn.

The research work which Dr. Canfield and his group are doing is purely clinical and involves analysis of clinical records in hearing cases. They have worked out a key sort card for all patients with hearing loss, and the cards will be analyzed from time to time to determine the type of hearing impairment most frequently seen in a clinic or in private practice.

At the New Haven Hospital there is a beginning project on skin resistance audiometry with a somewhat different type of apparatus than that used at Johns Hopkins. This study is in a preliminary stage, and the researchers have no idea yet whether or not the apparatus will actually work. Probably nothing will come from this study for another year.

GEORGE E. SHAMBAUGH, JR., M.D., 55 E. Washington St., Chicago 2.

At Northwestern University experiments with the fenestration operation on monkeys are being continued. These studies have been in progress for more than 10 years and have resulted in the improvement in technique which Dr. Shambaugh initiated and which has gradually been adopted by most surgeons performing the operation, i. e., complete removal of bone dust by irrigation and use of an operating microscope, enchondralization or doming of the fenestra, and preservation of the endosteum within the labyrinth.

In addition to this animal experimentation, Dr. Shambaugh and associates are carrying out a number of research projects in conjunction with Dr. Carhart, professor of audiology at the

Northwestern University School of Speech. These research projects include testing of the hearing of the patient in the course of the fenestration operation to determine the optimum size of the fenestra, a new test for cochlear reserve to supplement bone conduction tests, and a study on the diagnosis of otosclerosis before there is a noticeable hearing loss.

SOUND BRANCH, UNITED STATES NAVY RESEARCH LABORATORY, Submarine Base, New London Conn.

Over 50 studies on acoustics and hearing have been reported over a 10-year period. The work has been almost entirely that of J. D. Harris, Ph.D., and has been most comprehensive and thorough in all matters studied. In 1952 the following papers were published or prepared for publication:

Harris, J. D.: Remarks on Determination of Differential Threshold by So-Called ABX Technique, J. Acoust. Soc. America **24**:417, 1952; Pitch Discrimination, ibid. **19**:816, 1952; Historical and Critical Review of Loudness Recruitment, Mem. Rep. Aero M. Lab., No. 200, Sept. 1952; Several Short Term Effects Following Relatively Mild Acoustic Stimulation, J. Acoust. Soc. America, to be published.

Harris, J. D.; Haines, H. L., and Myers, C. K.: Loudness Perception for Pure Tones and for Speech, A. M. A. Arch. Otolaryng. **55**:107-133, 1952.

Harris, J. D., and Myers, C. K.: Experiments in Fluctuation of Auditory Acuity, Mem. Rep. Aero M. Lab., No. 196, Oct. 1952.

Harris, J. D., and Hartman, E.: Influence of Sensory Distance Between Stimuli on Absolute Identification of Pitch, Mem. Rep. Aero M. Lab., No. 206, to be published; Annotated Bibliography on Absolute Pitch, ibid., No. 207, to be published.

Harris, J. D., and Rawnsley, A. I.: Studies in Short-Duration Auditory Fatigue, Mem. Rep. Aero M. Lab., No. 199, May 1952.

NATIONAL RESEARCH COUNCIL, 1113 DuPont Circle Building, Washington 6, D. C., Stella L. Diegnan, Ph.D., director.

The files of the Medical Sciences Information Exchange, of the National Research Council, show that registered with the council there are 32 projects which deal with the ear. Of these, 23 are concerned with the auditory aspects of the ear and 9 with the vestibular aspects.

One may be interested to know the amount of money awarded for this research. This may be presented in two ways. According to the first, awards made in the governments fiscal year 1951, which began July 1, 1950, totaled $282,066, of which $242,151 was awarded for projects in the auditory group and $39,915 for those in the vestibular group. Of this amount less than $17,000 came from sources other than the United States Government. Secondly, if the figures are presented from another point of view and expressed as the amount of money awarded on the presently active segments of all the grants, regardless of the fiscal year in which the awards were made, a total of $395,725 is committed to these projects.

Notices of Research Projects.—Group 1 (Auditory): RG 653; B's 19 C3, 175; E 60 C4; GAB's 500, 18682; GAC 22645; ZAB 5; ZAC's 46, 47; GLF's 170 C4, 398, 608, 21, 201, 233, 322; GO's 577 C3, 2354 C1; PN 50; UA 40; UP 144 C1; PW 20. Group 2 (Vestibular): B's 35 C1, 45 C1, 64, 81; MH 389; GLF's 60, 166, 455, 916.

RESEARCH BY GOVERNMENT AGENCIES OR UNDER GOVERNMENT GRANTS

Auditory Acuity in Air Force Personnel: Standard, Hazards, Protection.—Major Elizabeth Guild, Dr. Juergen Tonndorf, Mr. Francis Brogan, Unites States Air Force School of Aviation Medicine, Randolph Field, Texas; supporting agency, United States Air Force.

Study of External Otitis.—Major James E. Lett, head, Department of Otorhinolaryngology, United States Air Force School of Aviation Medicine, Randolph Field, Texas; supporting agency, United States Air Force.

Anatomy and Physiology of the Auditory System.—Dr. Archie R. Tunturi, University of Oregon; supporting agency, Office of Naval Research.

Sensory Areas of the Human Cerebellum.—Dr. Averill Stowell and Dr. Robert A. Hayne, Springer Clinic, Tulsa, Okla.; contracting agency, United States Public Health Service.

Study of Responses in the Cochlea and Higher Acoustic Centers to Sounds of Suprathreshold Intensities.—Dr. Edward M. Walzl (deceased), associate professor of otolaryngology, Johns Hopkins University School of Medicine; contracting agency, United States Public Health Service.

Pharmacology and Physiology of Brain-Stem Functions.—Herbert L. Borison, instructor in pharmacology, and Louis S. Goodman, professor of pharmacology, University of Utah, College of Medicine, Salt Lake City; contracting agency, United States Public Health Service.

Comparative Studies on Patterns of Organization in Afferent and Efferent Systems of the Mammalian Cerebral Cortex and Cerebellum.—Dr. Clinton N. Woolsey, Slichter professor of neurophysiology; John W. Barnard, Ph.D., associate professor of physiology, and A. M. Travis, B.S., graduate student, Department of Physiology, University of Wisconsin; contracting agency, United States Public Health Service.

Nature of Sound Conduction in the Ear.—Prof. E. G. Wever, Princeton University; supporting agency, Office of Naval Research.

Basic Physiological Phenomena Associated with Auditory System.—Dr. E. H. Kemp and Dr. G. R. Wendt, University of Rochester; supporting agency, Office of Naval Research.

Efficiency of Nasopharyngeal Irradiation in Prevention of Deafness In Children.—Dr. Samuel James Crowe, adjunct professor emeritus of laryngology and otology; Dr. John Earle Bordley, adjunct professor of laryngology and otology, and William G. Hardy, Ph.D., associate professor of laryngology and otology, Johns Hopkins University; contracting agency, United States Public Health Service.

Auditory Efficiency in Noise.—Raymond Carhart, Ph.D., professor of audiology, director; Charles Lightfoot, Ph.D., research audiologist, and John Gaeth, Ph.D., assistant professor of audiology, statistical consultant, Northwestern University; supporting agency, United States Air Force School of Aviation Medicine.

Influence of the Nonauditory Labyrinth on the Functioning of the Human Organism.—Dr. Cecil W. Mann and Dr. Robert Brown, Tulane University of Louisiana; supporting agency, Office of Naval Research.

Functional Interrelationships Between Brain Stem and Cerebral Cortex.—Dr. H. W. Magoun, University of California at Los Angeles; supporting agency, The Commonwealth Fund.

Psychoacoustic Research in Hearing and Communications.—Dr. S. S. Stevens, Psycho-Acoustic Laboratory, Harvard University; supporting agency, Office of Naval Research.

Neurophysiology of the Vestibular System.—Dr. Harlow W. Ades, Emory University; supporting agency, Office of Naval Research.

Investigation into the Effect of Sensory Impulses on the Cortical Motor System, with Special Emphasis on the Visual and Vestibular Systems.—Dr. Patrick D. Wall, assistant professor of anatomy, University of Chicago; contracting agency, United States Public Health Service.

Nervous Pathways and Connections of the Auditory System.—Dr. Grant L. Rasmussen, principal investigator, and Dr. Ewart G. Bertram, assistant, University of Buffalo; supporting agency, Office of Naval Research.

Selective Filtration in Aids to Damaged Ears; Relations of Metabolic Changes in Hearing Efficiency.—Dr. H. Mortimer, Department of Medicine, McGill University; supporting agency, National Research Council, Canada.

Streptomycin in Tuberculosis.—Dr. H. McLeod Riggins, medical consultant and coordinator of chemotherapy studies, New York State Department of Health, Tuberculosis Control Division; supporting agency, United States Public Health Service.

Summary of Proposed Work: Studies of chemotherapy of tuberculosis have been continued essentially along the lines previously reported. The results of studies on 501 cases were recorded in last year's progress report. Since then, 111 additional cases have been studied, making a total of 612 studied since 1947. The second part of this study is still in progress and should

provide objective information regarding the relative late toxicity of dihydrostreptomycin sulfate and streptomycin sulfate for the hearing apparatus.

Development of Ear Defenders for Protection Against Noise.—Horace O. Parrack, Ph.D.; Donald H. Eldrege, Jr.; Ronald G. Hansen, and Anna M. Hliaras, Aero-Medical Laboratory, Engineering Division, Air Material Command; supporting agency, United States Air Force.

Study of the Discriminating Mechanism of the Ear.—Dr. Aaron Spector, Queen's College; supporting agency, The Society of the Sigma Xi and the Scientific Research Society of America.

Study of the Electroencephalogram in Normal and Pathological Nystagmus.—Dr. Donald J. Lyle, professor of ophthalmology, and Dr. Gustav Eckstein, professor of physiology, University of Cincinnati; Dr. John Fuhs, resident in ophthalmology, Cincinnati General Hospital, and Thomas B. Hackett, instructor in physiology, University of Cincinnati; contracting agency, United States Public Health Service.

Motion Sickness.—Dr. G. R. Wendt, University of Rochester; contracting agency, Office of Naval Research.

Clinical Study of Auditory Impairments.—I. J. Hirsch, Ph.D., research associate, principal investigator; E. Eldert, clinical audiologist, and H. Ludwig, electroacoustic engineer, Washington University Medical School, Central Institute for the Deaf, St. Louis, Mo.; supporting agency, Hofheimer Foundation.

HAROLD F. SCHUKNECHT, M.D., assistant professor, and JOHN R. LINDSAY, M.D., professor, Division of Otolaryngology, and Joseph Hind, B.S.E.E., research assistant, electronics engineer, University of Chicago, Chicago 37.

Research work is a study of functional and histological changes resulting from experimental lesions of the labyrinth; supporting agency, Veterans Administration.

HALLOWELL DAVIS, M.D., director of research, Central Institute for the Deaf, St. Louis.

Research on physiological acoustics has as supporting agency the Office of Naval Research. Research on methods of diagnosis of impairment of hearing and their application to problems of aural rehabilitation has as supporting agency the Veterans Administration.

JOHN R. LINDSAY, M.D., University of Chicago.

A summary of proposed studies on the function of the inner ear is as follows: Changes in the receptor cells, the nerve supply, and the fluid system of the inner ear will be produced by blast injury, by interruption of the blood supply, by lesions of the auditory nerve, and by damage to the nonauditory parts of the labyrinth. Hearing of experimental animals will be tested by conditioned response methods. The electrical responses of the cochleas of experimental animals will also be examined. The exact extent of the lesions produced will be determined histologically. An attempt will be made to develop more exact methods of measuring the forces applied to the inner-ear fluids through the conduction mechanisms. Supporting Agency is the Office of Naval Research.

S. R. SILVERMAN, Ph.D., Director, Central Institute for the Deaf, St. Louis.

Research deals with an evaluation of and reports on the acoustic properties of certain items of personal equipment; supporting agency, United States Air Force.

W. P. COVELL, M.D.; HALLOWELL DAVIS, M.D.; C. FERNANDEZ, M.D., and D. MCAULIFFE, M.D., Washington University School of Medicine, Euclid Ave. and Kingshighway, St. Louis.

Research consists of studies on the histological changes of the inner ear induced by intense sound; supporting agency, United States Air Force.

E. P. FOWLER, JR., M.D., in association with ANDERSON HILDING, M.D.; FRANZ ALTMAN, M.D.; JULIUS WALTNER, M.D.; Adolph Zeckel; Paul Lindenberg; Donald Markle, and visiting fellows, College of Physicians and Surgeons, Columbia University, New York City.

The following research projects have been undertaken:

1. Review of the bony and membranous anatomy of the final turn of the cochlea, with special attention to the details of anatomic structure of the tectorial membrane.

2. Methods for lighting thick anatomic preparations for microscopic study and a method for removal and dissection of the otic labyrinth without disturbing delicate anatomic structures within.

3. Exploration of a theory of hearing based on these findings, and an anatomic explanation of deafness from acoustic trauma and of tinnitus.

4. Origin of the perilymph and endolymph.

5. Changes in the brain stem and cochlea after cutting of the eighth nerve in cats.

6. Embryology of the ear.

7. Congenital deformities of the ear.

8. Experimental anomalies of the ear in rats.

9. Effect of streptomycin on salamander embryos; effect of dihydrostreptomycin on hearing.

10. Thresholds of angular acceleration.

11. Relation of vestibular vertigo to imbalance of the extraocular muscles and error of refraction.

12. Action of vestibular stimulation on ocular accommodation and convergence.

13. Sensitivities of various organisms to various antibiotics; bacteriological and clinical findings in external otitis.

14. Method of routine hearing tests for industrial, school, and military situations.

15. Treatments for Ménière's disease.

16. Study of paracusis Willisiana.

17. Study of circulation in various kinds of deafness.

18. Personality studies in the psychosomatics of Ménière's disease.

19. Clinical studies of congenital atresias and the use of skin graft and fenestration for this condition.

20. Causes of the closure of fistulas in monkeys.

VICTOR GOODHILL, M.D., 2007 Wilshire Blvd., Los Angeles.

Dr. Goodhill reports that he and his associates are engaged in the following studies:

Infantile Perceptive Deafness:

1. Methods of objective audiometry, including a critical study of psychogalvanic skin resistance technic.
2. Further studies on the Rh factor and other causes of nuclear deafness.
3. Further work on rubella deafness.
4. Progressive heredodegenerative deafness.
5. Multiple cases of infantile deafness in one family.

Otosclerosis:

1. Histopatology of ossicles removed at fenestration operation.
2. Clinical vascular study of otsclerotic patients.

Vascular Anatomy of Temporal Bone:

Basic anatomic study of vascular anatomy of optic capsule of Rhesus monkey.

Tinnitus:

1. Psychosomatic aspects of tinnitus.
2. Further studies on tinnitus-identification test.

CENTRAL INSTITUTE FOR THE DEAF, St. Louis.

The following list of research projects for 1952 was prepared in November, 1951, for publication in the *American Annals of the Deaf.*

1. Further development and validation of speech tests for impaired hearing.
2. Development of instrumentation for clinical auditory testing.
3. Further development of group hearing aids and study of their use in the education of the deaf.

4. Improvement of procedures for evaluation and selection of individual hearing aids.
5. Improvement of methods of measuring the performance of electroacoustic instruments.
6. Evaluation of the acoustic properties of certain military equipment.
7. Evaluation and electroacoustic measurement of audiometers and hearing aids.
8. Cooperation with Hofheimer Audiology Laboratory in (*a*) long-term follow-up of the auditory aspects of the fenestration operation; (*b*) objective clinical study of hydrops of the labyrinth, tinnitus, and diplacusis, and (*c*) study of the relations among various clinical procedures for measuring recruitment—loudness balance, differential limen, masking, and discrimination loss.
9. Study of auditory flutter in normal and hard-of-hearing listeners.
10. Study of auditory fatigue and temporary stimulation deafness as a function of the physical properties of stimulating sound.
11. Study of the physics and physiology of the inner ear by animal experimentation.
12. Cooperation with Department of Otolaryngology, Washington University School of Medicine, in a study of the injurious effects of loud sounds on the ears of animals.
13. Application of principles of conditioning to auditory testing of young children.
14. Comparison of the electroencephalogram and the skin galvanic reflex as methods for use in auditory diagnosis for young children.
15. Study of the intelligibility of speech in cases of cleft palate and the effects of speech aids.

Most of the research staff are part-time workers, doing also teaching, studying, administration or clinical work or being engaged in business. The staff of Hofheimer Laboratory, administered partly by Central Institute for the Deaf, is included in the following list: H. Davis, M.D.; S. R. Silverman, Ph.D.; H. S. Lane, Ph.D.; I. J. Hirsh, Ph.D.; I. Tasaki, M.D.; J. P. Legouix, M.D.; R. W. Benson, Ph.D.; R. Goldstein, Ph.D.; H. Ludwig, M.S.; E. G. Reynolds, B.A.; J. Detchemendy; M. P. Doyne, M.A.; D. K. Wilson, Ph.D., and D. McAuliffe, M.S.

The staff in July, 1952, reviewed their research projects, their budgets, and their personnel. The following list, which includes both work at the Central Institute for the Deaf and some of the work in progress in the Department of Otolaryngology of Washington University School of Medicine, has been submitted by Dr. Hallowell Davis. The projects involving acoustic trauma and the work of the Hofheimer Audiology Laboratory are really joint projects and cannot be separately attributed either to the Central Institute or to Washington University.

Washington University (Contract with Air Force).—Dr. Ben Senturia is conducting research on otitis externa with the assistance of about four full-time investigators.

Washington University (Contract with Air Force).—Dr. W. P. Covell is studying the pathology of acoustic trauma in animals. This work has been in progress for more than two years. The animals are or have been exposed to intense sound at the Aero-Medical Laboratory (Wright Field) or at Central Institute for the Deaf. Dr. Covell and his associates are studying the resulting pathological changes. This contract includes physiological studies of acoustic trauma at Central Institute (Dr. Davis).

Central Institute (Contract with Office of Naval Research).—Dr. Hallowell Davis and Dr. I. Tasaki are conducting animal experiments on the biophysics and neurophysiology of the ear and also psychoacoustic experiments with filtered clicks ("tone pips"). Two long papers are now in press. One deals with the acoustic analysis of sound in the cochlea and the other with the nature and significance of the electrical phenomena of the cochlea relative to excitation of nerve impulses.

Central Institute (Contract with Air Force).—Dr. I. Hirsh is carrying out psychoacoustic studies of auditory fatigue and phenomena of masking. This work is a continuation of Dr. Hirsh's previous basic studies conducted at the Psycho-Acoustic Laboratory, Harvard University.

Central Institute (Contract with Air Force).—Dr. S. R. Silverman, Dr. I. J. Hirsh, and Dr. R. W. Benson have carried out a project for which the contract has been terminated and the report submitted. It dealt with the acoustic properties of ear plugs and certain other items of military equipment.

Central Institute (Grant form National Institutes of Health).—Drs. I. J. Hirsh and R. W. Benson are engaged in basic research on temporal factors in audition. The psychoacoustic part of this project includes as its specific aims (*a*) an experimental study of the perception of time relations, including the duration of a signal, intervals between signals, and the rhythm or rate of recurrence of events; (*b*) the analysis of the information content of speech, and (*c*) the relation of the type of conditioning to basic psychophysical concepts, i. e., how the auditory threshold differs according to the procedure used to measure it. The project includes study of the electroencephalogram, the galvanic skin response, and the more familiar clinical procedures. The acoustic part of the project includes the design of instruments to produce brief acoustic signals and their application to methods of electroacoustic measurement.

Central Institute (Terminal Contract with Veterans Administration, to be continued under grant from National Institutes of Health).—Dr. Hallowell Davis and Dr. S. R. Silverman are studying the development and validation of methods of speech audiometry, including the preparation of recorded word lists. A table of values of the social adequacy index of hearing based on the new lists will be calculated, and the concept of social adequacy of auditory communication will be applied to the problem of medicolegal disability of hearing.

Washington University and Central Institute (Hofheimer Audiology Laboratory).—Dr. I. Hirsh, Dr. S. R. Silverman, Dr. Hallowell Davis, and Dr. T. E. Walsh are conducting clinical investigations of hearing, including the trial and validation of new auditory tests. The follow-up of patients on whom the fenestration operation has been performed is being continued in order to determine the incidence of late closure. Newer projects consist of clinical studies of nerve deafness, including the phenomena of recruitment, loudness balance, diplacusis, and tinnitus, and also the evaluation of tests of bone conduction.

Washington University.—Dr. K. Smith (Department of Otolaryngology) and Dr. Oliver Laurie (Department of Pharmacology) are carrying on microchemical analyses of perilymph, endolymph, and cerebrospinal fluid with special attention to protein, sodium, and potassium.

Central Institute for the Deaf.—Dr. S. R. Silverman, Dr. Hallowell Davis, and Dr. R. W. Benson are investigating hearing aids, the hearing clinic, the speech clinic, experimental phonetics, intelligibility of speech in cases of cleft palate, and the testing of audiometers (both clinical trial and acoustic measurements).

Central Institute (Grant from National Research Council).—Dr. S. R. Silverman and Mr. C. E. Harrison are studying further development and methods of use of group hearing aids as adjuncts to the education of the deaf.

University of Chicago, Chicago 37. Dr. John R. Lindsay has submitted the following report.

Dr. Henry B. Perlman has completed an investigation on the effect of interrupting the inferior cochlear vein in the guinea pig. According to Nabeya, venous return in the guinea pig cochlea goes entirely by way of the inferior cochlear vein from the scala tympani near the round window. Dr. Perlman found that interrupting this venous channel would not produce significant changes in the hearing of the animal as indicated by the cochlear microphonics. Apparently adequate collateral venous channels must exist. Dr. Perlman has repeated experiments of Wever and Lawrence demonstrating the effects of anoxia.

A project has been started by Dr. Perlman, Mr. Robert Kimura, and Dr. Lindsay to study the effects of sympathetic nervous control on blood circulation in the middle and inner ear. While circulation in the middle-ear mucosa is easily observed, the plan is to observe and to photograph circulation of the blood in the inner ear and to study the effect thereon of the autonomic nervous system.

Dr. Heinrich Kobrak continues laboratory and clinical studies on the use of the middle-ear prosthesis as well as study and photography of the action of various parts of the hearing mechanism.

Dr. Harold Schuknecht is completing experiments in which restricted lesions were produced in the cochleas of cats. The animals were conditioned for auditory testing. By this method he is able to study frequency localization within the cochlea. He has also performed partial section of the cochlear nerve to determine the frequency specificity of various regions in lesions of the nerve.

Dr. Lindsay has completed another series of experiments in which the ductus endolymphaticus was obliterated in the cat. Dr. Schuknecht further extended these experiments by obliterating the ductus endolymphaticus in animals conditioned to sound. He also obliterated the cochlear aqueduct as well as the accompanying inferior cochlear vein in sound-conditioned cats. This work is still in progress. For periods up to nine months there was no change in hearing as a result of obliteration of the ductus endolymphaticus. Also, no change in hearing followed obliteration of the cochlear aqueduct in animals in which the ductus endolymphaticus had previously been destroyed.

Mr. Joseph E. Hines, B.S.E.E., Ph.D., is working on the auditory cortex of the cat. He is exploring the tonopopic organization of the auditory cortex. Through the electrical activity evoked it has been possible to study the frequency sensitivity of the various regions of the cortex isolated by means of local application of strychnine. The study of cortical potentials in addition to providing basic neurophysiological information has proved useful as a test of peripheral auditory function in experimentally deafened animals.

Audiology and Speech Correction Center, Walter Reed General Hospital, Washington, D. C., Dr. Aram Glorig reports the following research.

1. The manifestations of the startle response to sound are being studied. Clicks are delivered through earphones at various high intensities up to 130 db. re 0.0002/dyne/sq. cm. The frequency and latency of the eye blinks following the stimulations are measured electrically and photographed. An attempt is being made to determine how loud clicks must be in order to elicit the eye blink. This research is only in the formative stages and has not been adapted to clinical use. It is hoped that the testing procedure may lend itself to studying special hearing problems. Among other things, it may be helpful in studying malingering and psychogenic deafness.

2. A standardized testing procedure for delayed speech feedback has been established for normal-hearing subjects. During the next phase of the study, effects of delayed speech feedback in persons with various types and degrees of hearing loss will be investigated. This testing technique promises to be valuable in clinical evaluation of malingering and psychogenic deafness.

3. Particularly in the case of malingerers, it has been found that the psychogalvanic skin response test is valuable as a lever in obtaining more accurate thresholds of hearing. A study comparing the results of the psychogalvanic skin response test with those of a follow-up standard audiometric test is in progress.

4. A research project in click audiometry has been completed which established thresholds for filtered clicks for a normal-hearing population. The next step will be to establish filtered-click thresholds for hard-of-hearing patients and to determine whether these thresholds have a diagnostic value.

5. The neurophysiological aspects of hearing loss are being studied by means of the electroencephalogram. This particular study is primarily concerned with the arousal response of patients who are malingering or who evidence psychogenic deafness.

6. Constant research is being done on the comparison of performance of different hearing aids. The aids are referred by the army and the Veterans Administration.

7. Two studies of audiogram analysis have been completed. In the first study the audiograms of 100 otosclerotic patients were analyzed, and in the second study the audiograms of 100 patients with otitis media were analyzed.

8. An investigation has been completed on the test-retest reliability of recorded spondees versus monitored live voice in establishing speech reception thresholds.

9. The test-retest reliability of recorded PB-50 tests (phonetically balanced speech discrimination tests) versus monitored live voice in establishing speech discrimination scores is under investigation. Also, different sensation levels are being explored to determine the loudness level at which an optimal speech discrimination score is obtained.

10. The psychological problems of patients who lost their hearing while in combat in Korea are being studied in relation to the psychological problems of hard-of-hearing patients who have not participated in overseas combat.

11. A study has been completed on the value of auditory training, in terms of improvement on speech discrimination scores, after the issuing of a hearing aid.

12. The files of the army aural rehabilitation center of the Deshon General Hospital have been made available for research. The administrative and medical data, hearing-test series, hearing-aid evaluation, and the patient's program of educational rehabilitation have been summarized on IBM cards for more than 3,000 patients. Such amassed data offer a tremendous number of questions to be explored. One problem under investigation is the relationship between the unaided binaural speech reception score and the better ear, pure-tone, air conduction threshold, conductive, perceptive, and mixed type of hearing loss being differentiated.

13. A study on measuring the physical movements of the eardrum includes use of equipment which will measure movements of the drumhead. These movements in one ear resulting from acoustic stimuli presented to the opposite ear will be studied.

14. Constant research is going on in the field of plastic ear inserts, since we are interested in developing an easily made ear insert which will be soft and therefore more comfortable and have a better seal.

15. An automatic screening audiometer (Glorig group screening audiometer) has been developed and is now being used in two army induction centers for the purpose of validation in regard to its practicability for screening tests on all inductees. A speech audiometer has already been developed and is now in use in the Veterans Administration and the larger general hospitals of the army.

Sound Section, National Bureau of Standards, Washington, D. C. Richard K. Cook, Chief, reports as follows on the work that the bureau is undertaking, much of which work will be most valuable to the practicing otologist in his threshold determinations of hearing.

> At present we are carrying on research into methods for calibration of hearing diagnostic instruments. This work is being financially sponsored in part by the Office of the Surgeon General, and the objectives of the research have been approved in principle by the Committee on Hearing of the National Research Council. The first objective is the development of an artificial ear whose physical characteristics more closely represent the acoustic impedance of the ear than does the artificial ear now in standard use. The standard ear now in use was developed in our sound laboratory a little more than 10 years ago and has been used continuously during the past 10 years for determining how well the sound output of an audiometer agrees with the standards for normal threshold. The development of the artificial ear involves research into the physical acoustics of the external ear and the eardrum. No physiological or subjective measurements are required. This development work has been under way for several years, and we expect to complete it in about two years. There are several ramifications of this problem which we are now exploring. The most obvious first requirement is the measurement of the acoustic impedance of a representative number of human ears. This work will be started soon with the collaboration of Dr. Aram Glorig's laboratory at the Forest Glen Annex of the Walter Reed General Hospital. A by-product of the investigation will probably be a new determination of the threshold of hearing. Work already completed includes a study of the effect of the force of application of an audiometer earphone to the ear, the statistical influence of anatomic differences in external ears, a new method for determining the correct threshold voltages for audiometer earphones by an entirely objective method, and the development of an instrument for recording directly a numerical measure of the impedance of the ear.
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> The other main line of investigation has been the standardization of the bone conductors used with audiometers. In contrast to the well-established standards for air conduction, no quantitative standards for the vibration produced by audiometric bone conductors exists as yet. As we see it, the first necessary step in such standardization work is the development of a method for measuring the acoustic impedance of the bones of the head. To date we have worked on the design of a driver to be used as a vibration source for the impedance measurements. We expect to make also a determination of the threshold of hearing by bone conduction. This means that we shall determine at various frequencies the amplitude of vibration, at the driver, of the bones of the head at the threshold of hearing. The impedance data, coupled with the threshold data, will enable

us to establish standards for the performance of the bone conductors used for making threshold measurements.

UNIVERSITY HOSPITALS, UNIVERSITY OF IOWA, Iowa City. M. Lierle, M.D., reports the following research problems being investigated by members of his staff:

1. New technique for measurement of recruitment.
2. Study of recruitment and its significance in certain types of hearing loss.
3. Study of autonomic dysfunction and its relation to symptomatology in otology.
4. Statistical study of pure-tone audiometry in relation to fenestration surgery.
5. Analysis of hearing after fenestration surgery.
6. Bone conduction thresholds after fenestration surgery.
7. Studies on auditory fatigue.
8. Detection of malingering.
9. Békésy audiometry.
10. Factors affecting lip-reading ability of adult hard-of-hearing patients.

PSYCHO-ACOUSTIC LABORATORY, HARVARD UNIVERSITY, Boston. S. S. Stevens, Ph.D., director; E. B. Newman, Ph.D.; G. V. Békésy, Ph.D.; J. Zwislocki; W. A. Rosenblith; K. Pribram, M.D., and B. S. Rosner, Ph.D.

Dr. Stevens has made the following report on research completed and under contract with the Office of Naval Research, United States Navy, with the support of the Bureau of Aeronautics and Bureau of Ships, from Nov. 16, 1951, to May 15, 1952.

The results of most of the laboratory's research are now being published in scientific journals. This process of publication is sometimes long drawn out, and delay between completion of project and its final availability in printed form may vary from a few months to a year or more. Consequently, the laboratory has adopted a policy of assigning consecutively a PNR (Psycho-Acoustic-Naval Report) number to each scientific report. This number is usually assigned after the research has been completed and the actual process of writing has begun.

Research Completed:

PNR-107: Electrical responses to two clicks: a simple statistical interpretation.
PNR-113: The generalized recovery curve for pairs of acoustic clicks.
PNR-128: A statistical description of neural responses to clicks recorded at the round window of the cat.
PNR-117: Responses to pairs of acoustic clicks at the round window and at the auditory cortex.
PNR-124: Measurement of the loudness of speech.
PNR-125: Effect of frequency and amplitude distortion on the intelligibility of speech in noise.
PNR-126: The loudness of bands of noise.

Research in Progress:

1. The effects upon auditory localization of training with a rotated binaural axis.
2. A statistical model for the analysis of the N_1 response to pairs of clicks.
3. The neural components of the round-window response to pure tones.
4. Sound produced by rubbing the skin with an electrode carrying an alternate current.
5. The effect of a tone in one ear upon the threshold of hearing in the other ear.
6. The role of bone conduction in cross hearing and in acoustic insulation at the ear.
7. Variability of cortical responses to acoustic clicks.
8. Electrical responses to acoustic stimuli in the monkey.
9. Effect of knowledge of the test vocabulary on articulation scores.
10. Supplement to the bibliography in audition.
11. Methods in the determination of abnormal pitch perception.
12. Pitch anomalies near tonal gaps.
13. A case of tonal monaural diplacusis.

CENTRAL BUREAU OF RESEARCH, AMERICAN OTOLOGICAL SOCIETY, INC. The Board of Trustees of the Research Fund, made the following report on May 19, 1952.

Dr. Barry J. Anson (Northwestern University Medical School) during the past fiscal year has been concerned with studies of the development and adult form of the otic capsule in the region of the vestibular aqueduct and in that of the cochlear (round) window. He has also continued studies with Dr. Theodore Bast on the late development and adult form and relations of the endolymphatic sac and the vestibular aqueduct.

With Dr. R. A. Davis studies are being completed and illustrated in an article on the development and adult morphology of the otic capsule in the region of the round window. In addition these researchers have instituted studies of the process of ossification of the otic capsule in the region of the petrosquamosal suture and occipital cartilage. With these and their prior reports on the general and regional features of development of the capsule the account of capsular morphogenesis may be considered completed. However, further studies will be approached from the developmental standpoint because of the belief that no aspect of normal or pathological anatomy or dysfunction dependent upon pathology in the ear can be fully understood unless the developmental steps in the formation of the particular part or structure have been completely traced. It is proposed to examine the concurrent steps in development of subdivisions of the otic capsule of the surrounding extracapsular layers, and of the auditory ossicles; in this way the separate phases of the investigations will be brought together and correlated chronologically. They plan to reexamine over 300 late fetal and early postnatal temporal bones and to chart statistically each type of osseous alteration noted in the region of predilection of otosclerosis.

Edmund P. Fowler, Jr., reports that the laboratory of Columbia University is actively experimenting on several fronts in attacking the various problems of otosclerosis.

1. Most basic have been the studies of Dr. Anderson Hilding on the cochlea, its anatomy and function in animals and humans. He has dissected over 100 cochleas of human beings and animals, concentrating on the tectorial membrane. Improved lighting techniques have been devised, and the phase microscope and sundry staining procedures have been used. It is believed that this study will reveal unique findings concerning the tectorial membrane and the areas of the auditory apparatus involved in low-tone deafness.

2. Studies on the personality of patients with otosclerosis and Ménière's disease have been extended to somatotyping so as to compare personality types and body types. This work has been done largely by Dr. Zeckel, Dr. Levy, and Dr. Sheldon.

3. Photographs of the conjunctival circulation of several patients with otosclerosis led to the belief that otosclerosis may be a circulatory disease and that information may be gathered about its progression if the circulation is studied. In patients with otosclerosis in the quiescent stage circulation appears to be normal, and certainly there is much less lumping in otosclerosis than there is in Ménière's disease.

4. Dr. Waltner has continued his studies on the origin of the endolymph, including histological localization of its source. It now seems to be fairly well established that the perilymph is not identical with the cerebrospinal fluid.

5. Dr. Altman continues his investigations of the changes in the cochlea and the brain after cutting the eighth nerve in cats and is cooperating with the American Academy of Ophthalmology on a film to demonstrate the embryology of the ear, including the growth of various bony foci.

6. Dr. Henri Moulonguet is studying unilateral paracusis Willisiana in cases of unilateral otosclerosis, along with unilateral nerve deafness and the vagaries of the Weber phenomenon.

Dr. John R. Lindsay (University of Chicago), reports the following progress in his experimental work:

Project E.

I. *A.* Experimental obliteration of the ductus and saccus endolymphaticus of the cat has progressed to a stage where sections are now ready for study of the small series of unconditioned cats first operated on as a preliminary.

B. In a second series, using cats which have been conditioned to sound, the animals' hearing has been tested periodically for several months after obliteration of the endolymphatic duct.

C. In order to utilize the conditioned animals in which the hearing had remained normal after obliteration of the endolymphatic duct, the aqueductus cochlearis and the cochlear vein were obliterated.

The endeavor is to provide information on three as yet unsettled questions: (1) the role of the ductus and saccus endolymphaticus in the maintenance of the endolymph; (2) the importance of the cochlear aqueduct in maintenance of perilymph, and (3) the circulation of blood in the labyrinth.

A surgical method has been developed for interrupting the venous channels from the labyrinth. The procedures described should, according to present conceptions, so affect the circulation that changes in function and morphology should be demonstrable.

II. Electrical potentials have been recorded from the auditory cortex both in normal and in conditioned cats. The effect of certain localized lesions in the cochlea on the animals' hearing was tested by the conditioned-reflex method, the potentials being recorded from the cortex. A fairly close correlation was found in the results. Further studies on the central auditory mechanism are planned by Joseph Hind, B.S.E.E., as the method has possibilities as an objective measure of hearing in experimental investigations.

III. Further experiments concerned with the problem of osteogenesis in newly created fenestras in animals have been carried out. It is possible that as more data are accumulated they may have some bearing on problems connected with otosclerosis, particularly neural degeneration and labyrinthitis or inner-ear damage after fenestration.

Studies in the chemistry of cartilage and bone are progressing. A full-time investigator is needed for this work, but it has been impossible as yet to obtain one.

Plans have been made to continue these investigations. In addition preliminary investigations have been started on the effect of the sympathetic nervous system on the hearing. Some of these projects may seem to have only a remote relationship to otosclerosis, but it is felt that basic research is essential along these lines to contribute to a better understanding of the physiological and pathological processes in the ear.

Edmund P. Fowler, Sr., reports that during the past year he has reexamined six of the seven pairs of identical twins with otosclerosis who have been under his observation for the past 4 to 11 years. There have been some interesting developments.

After one or more emotional episodes in one or both twins in four pairs there has been an increase in deafness and in two instances deafness in a previously nonaffected ear and coincidentally an increase in sludging of the blood.

Two pairs of twins are undergoing somatotype and psychological tests to determine correlations between body and personality types and the emotional status both at this time and before the onset of otosclerosis. Dr. R. H. Osborne, under the direction of Dr. William Sheldon, and Dr. Adolph Zeckel have generously given much time and thought to these studies.

In endeavoring to correlate emotional factors with changes in progressive deafness, Fowler cautions that one must constantly bear in mind that cause and effect have not been proved. However, with rare exceptions in his patients with otosclerosis he has found a definite tie-up between the emotional and the observed correlated factors, such as endocrine disorders, increase in the impedance deafness, and sludging of the blood.

The twins with osteogenesis imperfecta are now 11 years old. Their hearing remains normal and their sclerae blue. Their fractures are diminishing, but they are both still confined to their wheelchairs.

For the past three years Dr. Fowler, cautiously experimenting with corticosteroids in the hope that they might have some deterrent osteogenetic action, not only in incipient otosclerosis but after the fenestration operation in delaying or preventing the closing of the fistula, has observed no significant response. However, there has been a stabilizing effect emotionally. The patients claimed to have a sense of well-being not noticable before. These studies are continuing.

During the past year the long bones (tibias) of the monkeys that had received various-sized doses of estrogens were sectioned under the supervision of Dr. Franz Altmann. No significant changes were observed. The temporal bones also had revealed nothing significant. It would appear that unless there is a hereditery background (which no animal possesses) it

is impossible with estrogens to produce otosclerosis in these higher animals and possibly in man himself. It would appear that this observation also holds true for drugs, surgical procedures, or hormones.

As reported two years ago, a higher incidence of otosclerosis has been found in the youngest and oldest than in the middle siblings of families with otosclerosis. This study is being continued in the hope that it may contribute something to a better understanding of the emotional factors in otosclerosis.

In a study of sludging of the blood, the main difficulty has been to evaluate the meaning of the differing degrees and character of the sludge. It would appear that the duration, consistency, and speed of transit of the masses are of more importance than their mere presence or even their size. Fowler in his discussion of the causes of anoxia and the symptoms and pathology dependent upon it points out that a stimulus is needed to cause localized vascular spasm but that in most instances it is difficult to determine the stimulus; also that when arteries are thin-walled and therefore have little muscle, they are less reactive to stimuli than larger vessels with larger muscles, so that it is the latter which largely determine the pattern of the lesions resulting from spasm and associated phenomena.

Management and treatment are discussed from the standpoint of allaying the fears patients have of going deaf and of emotional stabilization. The otologist should endeavor to instill in patients a proper philosophy of life, of sickness, and of handicaps; to make them realize that their overemotional responses to their deafness are detrimental to them and annoying to their families, and to convince them that their emotional state is really their own doing and not just a result of the deafness, in other words, that it is largely their fault and not the fault of others. Management along these lines probably accounts for much of the improvement in hearing erroneously credited in some cases to use of vitamins or other therapy.

The phenomenon of "recruitment of loudness" has been of increasing interest here and abroad. Fowler does not agree with Hallpike and his co-workers that recruitment occurs only with peripheral neural mechanism lesions. He believes that masking may have interfered with Hallpike's testing. He has himself found two cases of neurinomas in which the recruitment phenomenon was typically present preoperatively. Fowler has devised a method for eliciting "recruitment," using beats.

A paper, "Tests for Hearing Impairment and Disability: An Analysis of the Pure-Tone and Speech Tests for Clinical and Compensation Purposes," read at the sectional meeting of the American College of Surgeons in Atlantic City, N. J., on Feb. 12, 1952, is to be printed in *The Journal of The American Medical Association*. It is stressed that without an otological diagnosis tests for arriving at a percentage figure for allocating compensation are unfair, are not based upon fact, and may be very misleading.

In two-thirds of Fowler's patients having otosclerosis there is a tendency for a shift to the left in serum phosphorus-calcium. The difficulties, and particularly the time element in blood-chemistry determinations, are discussed. Fowler believes that, although no answer as to etiology, prevention, or treatment has been found, some of the leads herein set forth should be followed up. He plans to do so.

AUDITORY TUBE AND TYMPANIC CAVITY DURING EMBRYONAL, FETAL, AND PRENATAL LIFE

Histologic Study

MARVIN J. TAMARI, M.D.
CHICAGO

REVIEW OF THE LITERATURE

KOPPEN,[1] who first studied the ear of newborn infants, believed the tympanotubal cavity to be filled with "more or less thickened liquid during the embryonal life." Von Troeltsch [2] was the first to recognize that the bony middle ear is occupied by a jelly-like mass. He suggested that the mass decreased by a progressive surface desquamation. Zaufal [3] believed the decay of the contained mass to be due to a purulent destruction and synovial-like liquefaction. On the basis of histological studies, Wendt [4] suggested that the reduction of the gelatinous mass is due to a rapid loss of intercellular fluid and that the resorption of the fluid is activated by the first influx of air into the tube with the initial respiratory movement.

Aschoff [5] examined macroscopically and histologically 86 premature and stillborn infants and 9 fetuses. His material was transported from Hannover to Goettingen, Germany, without previous fixation. An abundant bacterial flora developed in the head cavities. Aschoff observed the amniotic fluid to enter the tympanic cavity of the embryo as early as the fourth month. He concluded that so-called otitis media neonatorum does not exist and that the presence of leucocytes and fat cells represents a form of foreign body reaction.

The term otitis media concomitans was introduced by Wittmack.[6] He believed that in very early fetal life the stomach contents, analogous with the amniotic fluid, may be aspirated into the middle ear and produce changes in the tympanic mucosa similar to a foreign body inflammatory reaction. The reaction of the mucosa produces a so-called latent hypoplastic otitis in infants with the secondary invasion of bacteria. The mucosal changes have a definite influence on the postembryonal

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Candidate's thesis presented in partial fulfillment of the requirements for membership in the American Laryngological, Rhinological and Otological Society, Inc.

1. Koppen, W.: Beobachtungen über Ansammlung von Flüssigkeit in der Trommelhöhle Neugeborner, Marburg, C. L. Pfeil, 1857.

2. von Troeltsch, A. F.: Die Untersuchung des Gehörorganes an der Leiche, Verhandl. Würzburger med. Gesellsch. **9**:77-78, 1858.

3. Zaufal, E.: Sectionen des Gehörorganes von Neugebornen und Säuglingen, Oesterr. Jahrb. Pädiat. **1**:118-124, 1870.

4. Wendt, H.: Beiträge zur pathologischen Anatomie des Ohres, Arch. prakt. Heilk. **11**: 567, 1870.

5. Aschoff, L.: Die Otitis media neonatorum, Ztschr. Ohrenh. **31**:295-346, 1897.

6. Wittmack, K.: Über die normale und die pathologische Pneumatisation des Schläfenbeines, Jena, Gustav Fischer, 1918.

development of the entire pneumatic configuration of the temporal bone. This results in a pathological pneumatization complicated by subsequent infections of the middle ear.

Hemsath [7] found evidence of numerous groups of cornified epithelial cells in the tympanum of stillborn infants. He likewise described a mild foreign body reaction

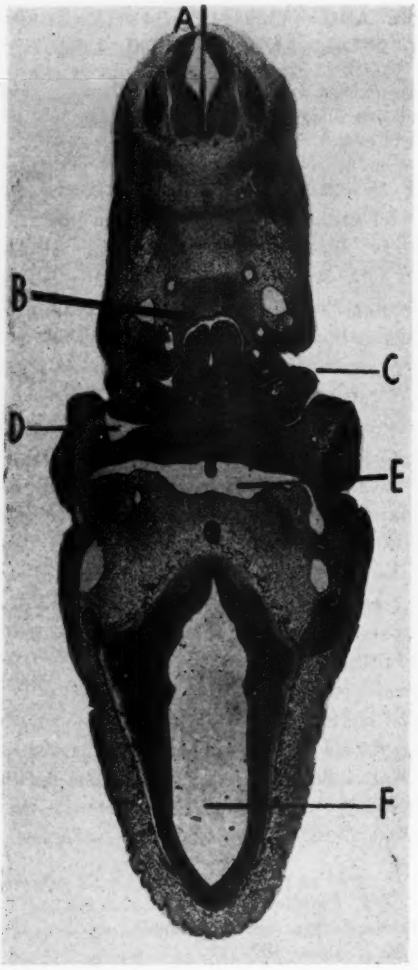

Fig. 1.—Cross section of a 9.5 mm. human embryo at the level of the branchial clefts. *A*, spinal cord and ganglia; *B*, pharynx; *C*, branchial clefts; *D*, Eustachian tube anlage; *E*, oral cavity; *F*, diencephalon.

with endothelial leucocytes and multinuclear foreign body giant cells. He cited two cases of foreign body reactions in the middle ear caused by solid constituents of

7. Hemsath, F. A.: Intra-Uterine and Neonatal Otitis: Study of 7 Cases, Including Case of Otitic Meningitis, Arch. Otolaryng. **23**:78-92, 1936.

amniotic fluid. The same observer listed three other instances of otitis media in newborn infants following a premature rupture of the amniotic sac without, however, showing any findings of aspiration pneumonia.

Dodds,[8] in a report of a case of otitis media and meningitis in a 9-day-old infant, stated that the middle ear at birth is filled with embryonal mucosa and that the

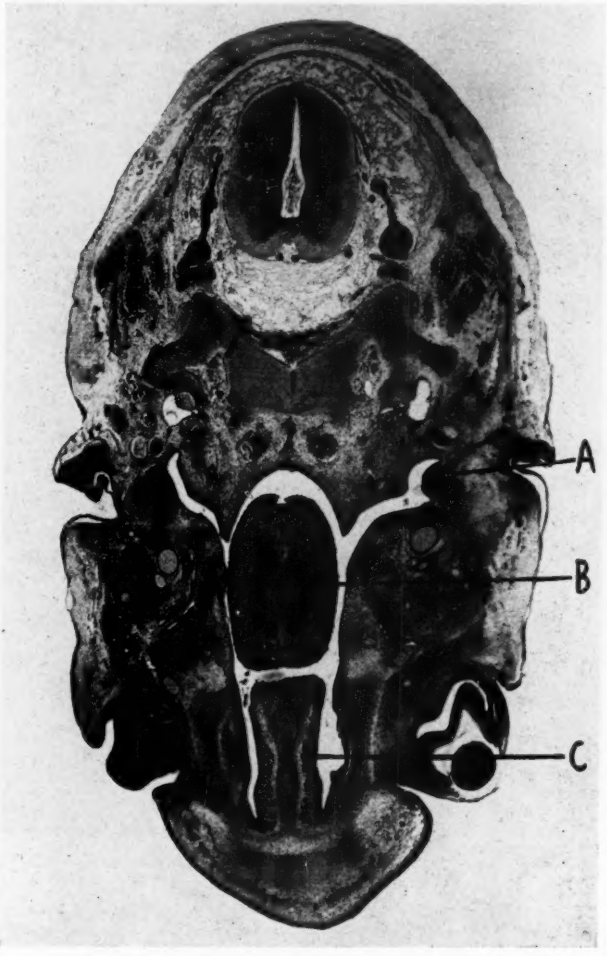

Fig. 2.—Cross section of a 25 mm. human embryo at the level of the middle ear. *A*, tympanic cavity anlage; *B*, tongue; *C*, nasal septum. The dorsal surface is at the top of the illustration.

entrance of air or fluid with the first act of deglutition is responsible for the formation of the middle ear cavity.

8. Dodds, G. H.: Otitis Media with Purulent Meningitis in Infant 9 Days Old, Arch. Dis. Childhood **6**:71-73, 1931.

Fischel [9] found that during fetal life the tympanic cavity is filled with a clear yellow-tinted fluid, disappearing from the middle ear at birth and after a few hours of breathing becoming replaced by air. Only then, the author feels, is hearing sensation possible.

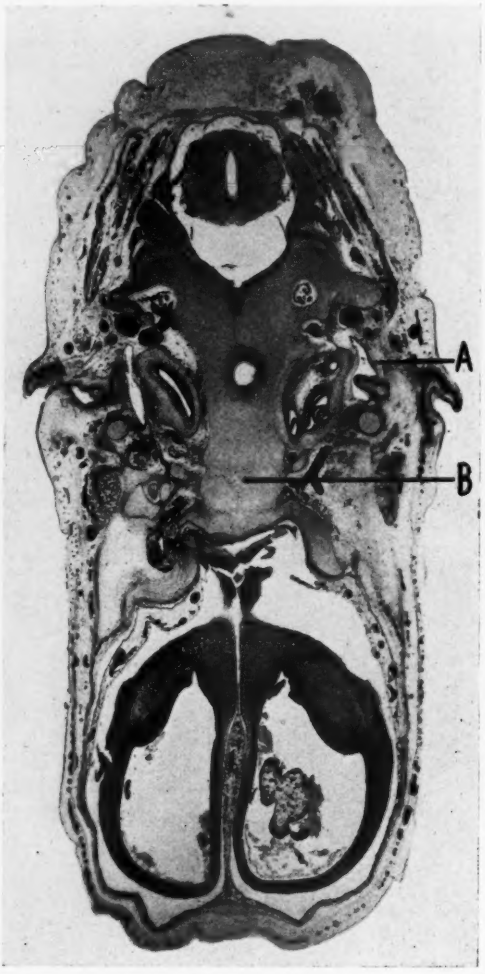

Fig. 3.—Cross section of a 32 mm. human fetus at the level of the middle ear. *A*, tympanic cavity; *B*, basisphenoid. The dorsal surface is at the top of the illustration.

In their exhaustive study of the origin and distribution of air cells in the temporal bone, Bast and Forester [10] stated that pneumatization of the middle ear is slow and

9. Fischel, A.: Lehrbuch der Entwicklung des Menschen, Berlin, Springer-Verlag, 1929.

10. Bast, T. H., and Forester, H. B.: Origin and Distribution of Air Cells in the Temporal Bone, Arch. Otolaryng. **30**:183-205, 1939.

is not completed until late in fetal life. They demonstrated histological evidence in a 22-week embryo with a partly pneumatized lower part of the middle ear.

Rüedi,[11] who studied histological sections of 10 fetuses, discussed the widening of the middle ear lumen as a mesodermal rather than an epithelial function but did not refer to the lumen of the auditory tube or the middle ear proper.

Fig. 4.—Sagittal section of 2½-month human fetus at the level of the utricle. *A*, utricle; *B*, stapes anlage; *C*, middle ear space.

In his contribution concerning the physiological and pathological formation of air cells, Ojala[12] stated that the free middle ear lumen, being filled with amniotic fluid, can be enlarged only when the "dead substance," meaning amniotic fluid, increases.

11. Rüedi, L.: Die Mittelohrraumentwicklung vom 5. Embryonalmonat bis zum 10. Lebensjahr, Acta oto-laryng., Supp. 22, pp. 1-132, 1937.

12. Ojala, L.: Contribution to the Physiology and Pathology of Mastoid Air Cell Formation: Histological Studies of Aged Individuals and Newborn Infants, Acta oto-laryng., Supp. 86, pp. 1-134, 1950.

According to Perlman,[13] the tympanum is a closed space after birth with one elastic wall, represented by the tympanic membrane. In fetal life, the tube opens only on swallowing. This occurs incidentally, and at such times as the amniotic fluid enters the middle ear cavity.

MATERIAL AND METHODS

The material of this study includes all stages of the formation of the auditory tube and the extended middle ear space from the development of the primitive pouch to the fully expanded

Fig. 5.—Section from a 14½-week human fetus, showing caudally enlarged middle ear space.

middle ear of the newborn. It comprises sections of human embryos and fetuses from the collection of the anatomical and otolaryngological departments of the University of Illinois.

Embryonal and fetal heads under 5 months of age were preserved in toto. Temporal bones of older fetuses and of newborn infants were separated from the adjacent parts and preserved

13. Perlman, H. B.: The Eustachian Tube: Abnormal Patency and Normal Physiologic State, Arch. Otolaryng. **30**:212-238, 1939.

in a 40% solution of formaldehyde. All specimens were decalcified either in a 5% solution of nitric acid or, for better conservation of soft tissues of younger fetuses, in a mixture of 50% formic acid and a 20% sodium citrate solution.

Ten series of embryonal and fetal sections were made available for study through the courtesy of the embryology and dental departments of the University of Illinois. These were

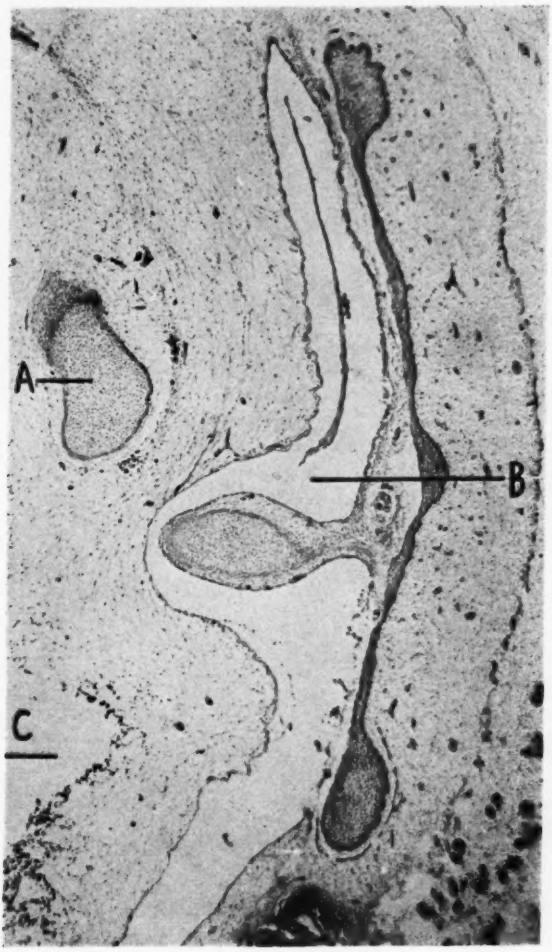

Fig. 6.—Horizontal section at the level of the stapes anlage of a 14½-week human fetus. *A*, stapes anlage; *B*, middle ear space; *C*, loose mesenchyme.

impregnated with Perenyi's solution, a mixture of 10% nitric acid, alcohol, and a 0.5% chromic acid solution.

The opening of the antrum and of the semicircular canals was omitted, as it was found unnecessary to achieve a satisfactory penetration of the decalcificants. Most of the prepared temporal bones were examined roentgenologically before they were processed through alcohol and celloidin. The embryonic material and that from younger fetuses were embedded in paraffin

The specimen blocks were sectioned vertically or transected horizontally, the individual slides being respectively 10 and 15 to 17 μ thick. Every fifth and, in the older series, every tenth section was studied.

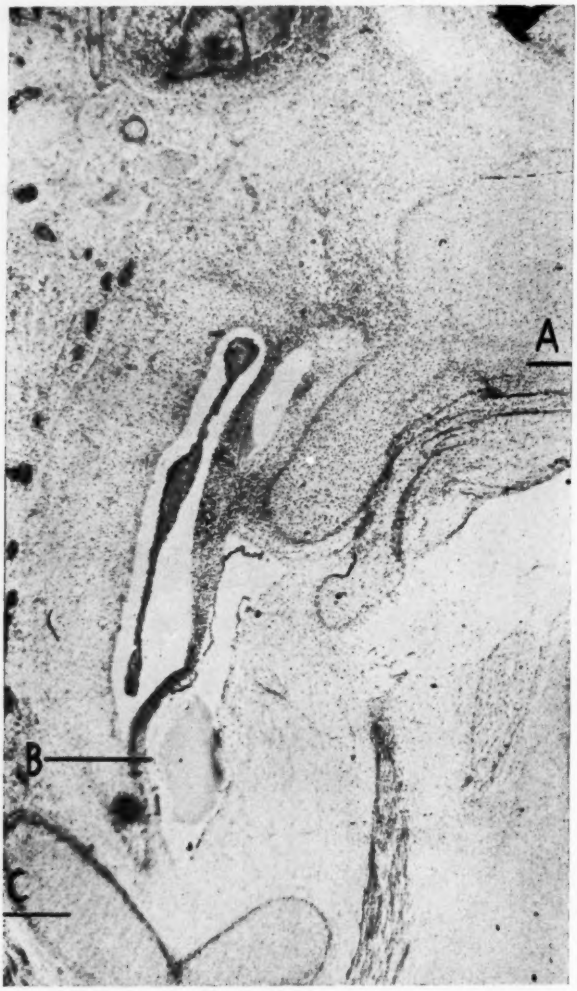

Fig. 7.—Horizontal section of a 3½-month human fetus. The middle ear space is partly filled with a coagulated mass. *A*, cartilage of Meckel; *B*, middle ear space; *C*, cartilage of Reichert.

For routine staining hematoxylin and eosin were employed. For special tissue study, Giemsa or Weigert staining methods were used.

Twenty-four complete series of embryos and fetuses are included in this study.

PHASES OF DEVELOPMENT AND PATENCY OF EUSTACHIAN TUBE

Certain photomicrographs have been selected to demonstrate the characteristic development of the auditory tube and the middle ear space with its contents.

In a horizontal section of a 9.5 mm. human embryo (Fig. 1) the first pharyngeal pouch may be distinguished as the anlage of the auditory tube. It appears triangular in form, and its epithelium is stratified, not differentiated. The lumen appears to be empty.

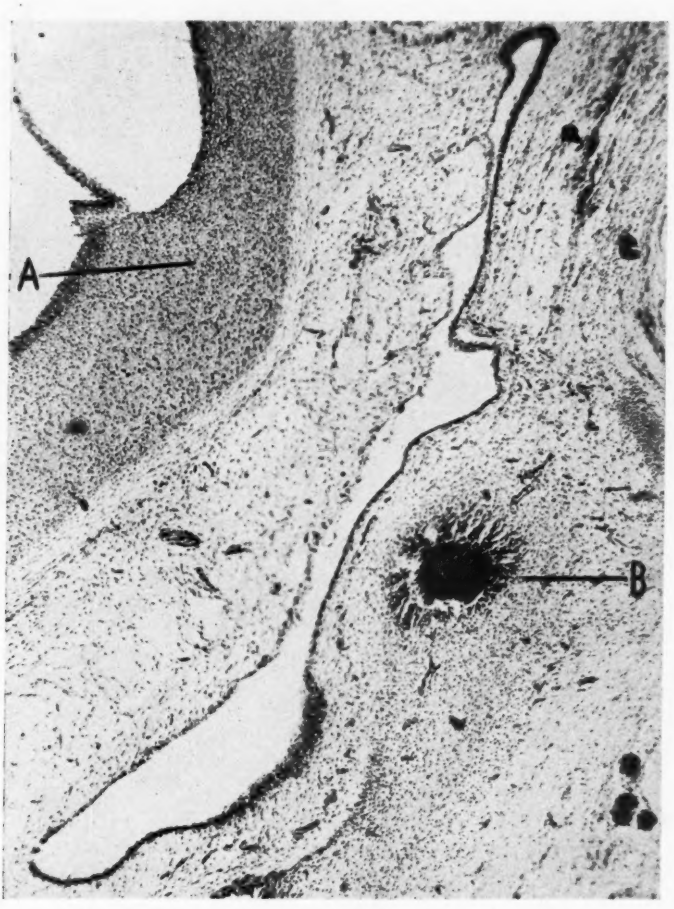

Fig. 8.—Horizontal section of a 3.7-month human fetus, showing slightly folded mucosa of the caudal portion of the middle ear space. *A*, cochlear cartilage; *B*, tympanic bone.

The formation of the middle ear anlage may readily be recognized in a transverse section of a 25 mm. embryo (Fig. 2). The lumen of the prospective cavity appears empty on the right side. On the left side, the tympanic anlage is partly filled with an amorphous mass similar to the accumulation found in some sections of the oropharyngeal anlage.

In sections of a 32 mm. (2½-month) human fetus (Fig. 3) the influence of the growing cartilage on the shape and formation of the future tympanic cavity is well

Fig. 9.—Section of 4-month human fetus, showing amniotic fluid admixtures in the middle ear space.

Fig. 10.—Vertical section through the Eustachian tube of a 4-month human fetus, showing amniotic admixtures in the tube.

demonstrated. In some sections, the lumen of the cavity appears clear; in others, a pink-stained serum-like fluid, free of cellular elements, is recognized.

In a sagittal section of a 2½-month human fetus at the level of the utricle (Fig. 4), the middle ear space is modified by the growing primordial cartilage. The epithelial lining is thin and intact throughout the cavity. The lumen is free of admixtures. The mesenchyme appears loose in texture and protrudes into the cavity anterior and posterior to the cartilage.

In a 14½-week human fetus, the middle ear space appears somewhat enlarged caudally (Fig. 5). The mucosa is slightly folded and the lumen of the cavity is empty.

Fig. 11.—Section from a 4.6-month human fetus, showing an amorphous mass (arrow) penetrating the mucosa of the middle ear space near the tympanic orifice.

In a horizontal section of another 14½-week human fetus (Fig. 6), the configuration of the middle ear space is determined by the growing primordial cartilages of Meckel and Reichert. The epithelial lining of the cavity consists of a layer of thin flat cells with a differentiated subepithelial layer. A large area of mesenchyme appears very loose. The lumen of the middle ear space is free of admixtures.

The middle ear slit is filled with a pink eosin-stained mass in the area between Meckel's and Reichert's cartilage in a horizontal section of a 3½-month human fetus (Fig. 7). There are no cellular admixtures present except loosened epithelial lining cells. The pink mass resembles a coagulated protein-containing fluid.

In a horizontal section of a 3.7-month human fetus (13.5 cm. long), the caudal portion of the middle ear space appears irregular and moderately folded (Fig. 8). The cells of the submucosal mesenchymal tissue near the tubal area seem to be separated by some fluid, such as is observed in edema.

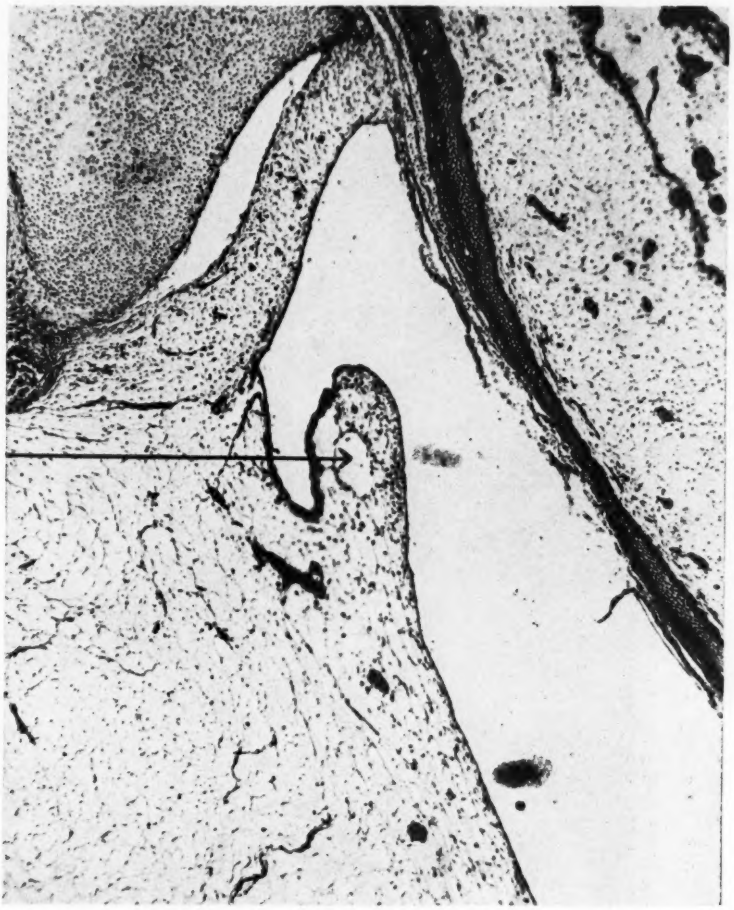

Fig. 12.—Section from 4.6-month human fetus, showing mesenchymal projections (arrow) into the lumen of the middle ear space.

The regularly outlined lumen in the middle ear space is evident in a 4-month human fetus (Fig. 9). The mucosa is thin; the mesenchymal tissue appears loose. The cavity contains irregular-shaped amorphous structures and some spherical corpuscles resembling red blood cells. They stain grayish-red with eosin and represent admixtures originating in the flow of amniotic fluid, which contains many deformed cellular elements at that stage of development.

The lumen of the Eustachian tube in a vertical section of a 4-month fetus (Fig. 10) contains desquamated cells with partly preserved nuclei. Other admixtures consist of spherical homogenous corpuscles and rudimentary fibrils, probably derived from the amniotic fluid.

Fig. 13.—Section from 25 cm. human fetus, showing scanty leucocytic accumulations in the middle ear space. *A*, tympanic bone; *B*, labyrinthic bone; *C*, tympanic membrane; *D*, tensor tympani muscle; *E*, leucocytic accumulation; *F*, tympanic bone.

In a slit-like extension of the auditory tube (4.6-month human fetus) toward the middle ear space, an amorphous, homogenous mass can be recognized penetrating the mucosa (Fig. 11). This mass or foreign body appears brownish in the stained section. Round corpuscles surrounding the mass represent remnants of the injured mucosa. There are, however, no signs of an inflammatory reaction in the tissue.

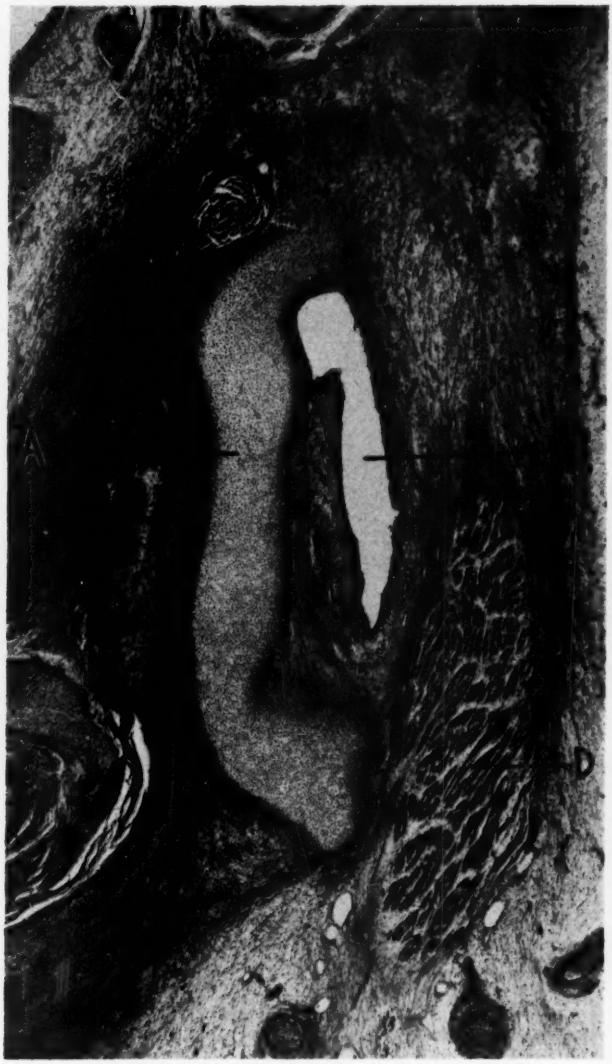

Fig. 14.—Section through the Eustachian tube of a 25 cm. human fetus, showing a free lumen. *A*, tubal cartilage; *B*, lumen of the Eustachian tube; *C*, tensor veli palatini muscle; *D*, carotid artery. The dorsal region is at the top of the illustration.

The mucosa and the underlying loosened mesenchyme form projections into the lumen of the cavity in some sections of a 4.6-month fetus (Fig. 12). These polyp-like excrescences show large empty-appearing areas, apparently due to an increase in intercellular fluid in the mesenchymal fluid.

In a number of sections through the middle ear cavity of a 25-cm. human fetus at the level of the tensor tympani muscle, accumulations of leucocytes were found (Figs. 13 and 14). There were no inflammatory reactions observed of the mucosa or the underlying mesenchymal tissue adjacent to the leucocytic accumulations. Similar leucocytes were seen in the nasopharyngeal cavity. They were aggregated

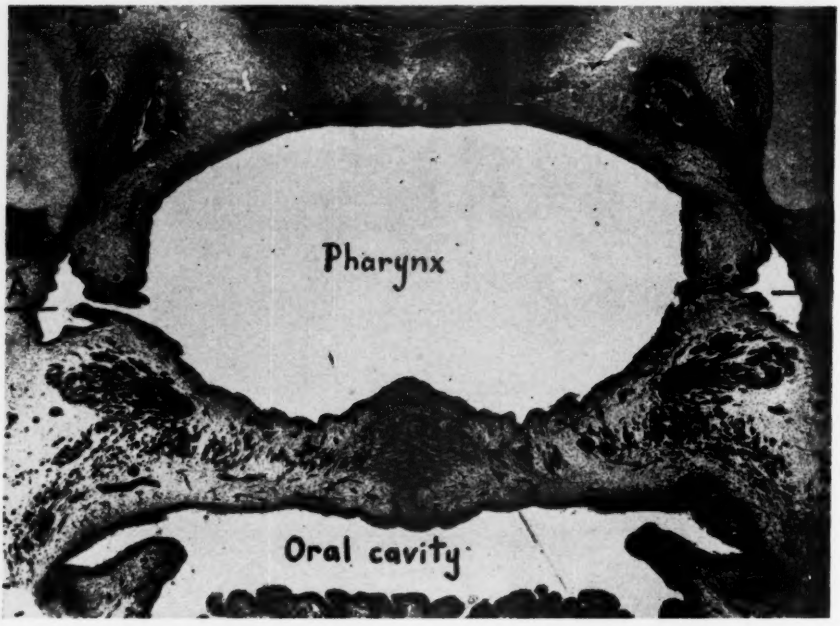

Fig. 15.—Vertical section from a 25 cm. human fetus, showing a supposedly obliterated left Eustachian tube. *A*, patent Eustachian tube; *B*, supposedly obliterated tube.

in a network of an undetermined fibrin-like tissue. The leucocytic cells in the middle ear cavity probably had been forced in with the exchanging flow of amniotic fluid. The lumen of the opposite Eustachian tube evidenced no leucocytic invasion.

Both Eustachian tubes are demonstrated in a vertical section of a 25-cm. human fetus (Fig. 15). The left tube gives the appearance of a temporary compression of the lumen. Sections anterior to the obstruction at the same level show a completely patent lumen.

In a vertical section of a stillborn child (Fig. 16) the lumen of the middle ear appears partly filled with a coagulated mass, containing a few leucocytes and desquamated cells, especially in the tubal area. Signs of an inflammatory reaction are

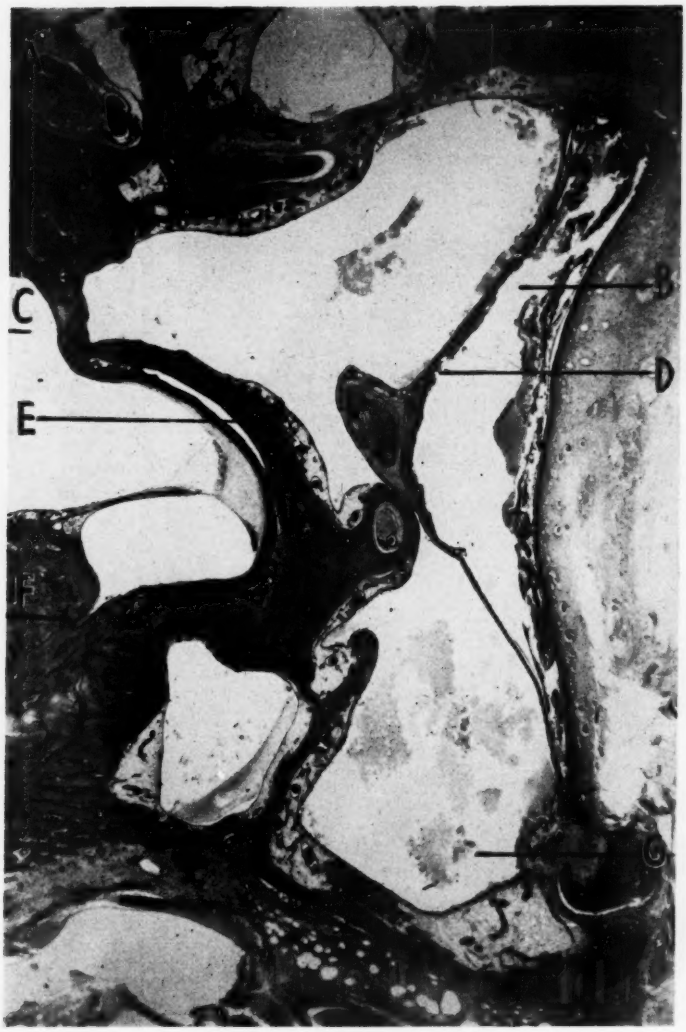

Fig. 16.—Vertical section through the middle ear of a stillborn child, showing coagulated debris in the cavity. *A*, facial nerve; *B*, external auditory canal; *C*, vestibule; *D*, tympanic membrane; *E*, promontory; *F*, cochlear aqueduct; *G*, hypotympanum.

Fig. 17.—Section from stillborn child, showing polyp-like protrusion of mesenchymal tissue in the hypotympanum. *A*, tympanic membrane; *B*, mesenchymal protrusion; *C*, external canal; *D*, tympanic bone.

lacking. Only the submucosa of the hypotympanic area exhibits enlarged capillaries, probably due to terminal asphyxia.

A large polyp-like excrescence is seen in anterior sections of the same series, representing a delayed absorption of the submucosal mesenchyme (Fig. 17).

COMMENT

In sections of the primitive tubotympanal cavity, as well as of the more differentiated middle ear cavity, and later of the newborn and early infantile cavity, one observes only slight remnants of the previous contents of the space. On this subject, no author mentions the physiological contents, with the exception of a few who assume that the middle ear of a newborn infant is filled with amniotic fluid. The impression is gained, from the study of pertinent passages in many published reports of investigations, and even in treatises on embryology, that the head cavities appear "empty" during embryonal and fetal life and become filled with air at the beginning of respiration.

This concept also leads to the erroneous theory that the so-called pneumatization of the temporal bone occurs as early as the fifth or sixth month of fetal life, although the view that the cavities become filled with air only at the beginning of respiration is in conflict with the absence of air at this stage of development.

Evidence of the future middle ear cavity and the antrum, with the recesses and cavities of future development, may be found as early as the fifth month of fetal life. These spaces are filled with mesenchyme, not solely in the area of the middle ear but also in the apex of the pyramid, with or without direct connection with the antrum. Pneumatization—that is, the filling of these spaces with air—does not exist at this stage of development. Therefore, the term pneumatization should be applicable only to the biological period; i. e., after the active ingress of air.

When I discussed this problem with embryologists, the thought was entertained that some apparently empty spaces in a fetus could be filled with gases, such as oxygen, nitrogen, or carbon dioxide, which apparently are present in minute amounts. Actually, there is no established physiological evidence that these gases are free, or could be measured in any part of the organs of a fetus, or could fill the tubotympanal sac specifically.

According to Fischel and others, the human embryo floats freely in the amniotic cavity during the second month of the developmental period. The amniotic fluid is of watery consistency, appears water-clear or slightly yellow, and gives a faint alkaline or neutral reaction. Sometimes it becomes milky from suspended particles of protein, salts, or vernix caseosa. It contains lanugo cholesteroids and glycerids. The solids amount to about 1% of the total volume. Evidence of admixtures of meconium can be found in the amniotic fluid if the child becomes asphyxiated before birth.

It appears to be an important factor for the life of the fetus that the amniotic fluid does not remain stagnant. Vosburgh [14] found that the water in the amnion exchanges at the rate of one-third of the total contents per hour. Significant also is

14. Vosburgh, G. J., and others: Rate of Renewal in Woman of Water and Sodium of Amniotic Fluid as Determined by Tracer Techniques, Am. J. Obst. & Gynec. **56**:1156-1159, 1948.

the demonstration of Szendi,[15] who has proved that the amniotic fluid enters the lungs and the gastrointestinal tract as soon as these structures begin to develop (26 mm. embryo). Both discoveries emphasize the embryonal function of the fluid and establish the biological fact that all embryonal and fetal cavities are in communication with the amnion.

In the primitive and the more differentiated tubotympanal cavities the fluid seems not to remain constant; it probably fluctuates with the exchange of water. If the contents of the watery fluid have no admixtures, the sections of the cavities appear empty, as a result of the customary preparation with formaldehyde or nitric acid solution and also of the drying procedures with alcohol.

In some of the sections of the temporal bone in this series, pink-stained masses similar to a transudate without cellular content may be observed. Whether this pink-stained mass is richer in proteins could not be determined by the usual and routine staining methods. Only in a few sections of the same series could loose epithelial cells, amorphic or crystal-like minute accumulations be found.

In the last stages of the development, the jelly-like mesenchymal tissue with a few cellular elements was observed in this series. The intercellular spaces are widened, and large "empty" spaces are evident in sections, demonstrating the fluid-filled areas. This loosening of the mesembryonal tissue results in a sudden loss of tissue fluid after birth and favors a rapid regression of the tissue itself. As a result, air enters from the pharynx, apparently the usual route of ingess.

As early as the fifth month, polypoid protrusions of the mucosa are observed at the site of the future ear cavity or in the existent minute cavity which is filled with fluid. These protrusions have been regarded as pathological formations and forerunners of alterations in the mucosal structure. In the series under consideration, no histopathological changes with inflammatory characteristics were found. The protrusions apparently represent physiological surface increments which carry abundant mucosa to pave the suddenly enlarged middle ear cavity. These polyp-like protrusions were found to persist in older persons, but they probably represent mucosal areas with a hyperplastic and loose submucosa.

Accumulations of a few leucocytes and fibrinous tissue were found in some sections in the middle ear of a 5½-month fetus. The mucosal and submucosal reaction could be described as indifferent because of lack of cellular infiltration. No submucosal changes or vascular enlargement could be found. Accumulations of these cells were noted in the inferior or tubal end of the middle ear; they were considered terminal deposits from the tube, probably during a phase of fluid exchange.

True infections of the middle ear cavities have been observed by many investigators. In the series herewith reported, it was possible to study sections of a 27 cm. fetus with an accumulation of pus cells in the middle ear slit. The tympanic membrane, which was not separated laterally, appeared edematous and the submucosal vessels evidenced perivascular cellular infiltrations. The loose subepi-

15. Szendi, B.: Weitere Aufklärung der Morphologie und Biologie des schwangeren Uterus und des Fetallebens mittels Röntgenuntersuchungen (Embryographie), Arch. Gynäk. **170**:429-456, 1940.

thelial tissue under the thin mucosa does not generally exhibit a larger network of vessels. This fact may be accounted for by the often prolonged and occult course of infection whenever embryonal tissue remains unabsorbed in the cavity.

In all stages of the development, the lumen of the Eustachian tube was found to be permanently patent. In some sections, it appeared narrowed because of a protruding mucosal fold, but there was no interruption of the lumen. The impression of a complete obstruction was created mainly by an oblique or uneven cut through a bulging mucosa in the particular section under study. Subsequent sections constantly revealed a complete continuity of the lumen of the auditory tube.

SUMMARY

In histological sections of the auditory tube and of the middle ear, the lumina appear empty in the first three months of development. In this period the amniotic fluid remains water-clear. The pseudo-emptied lumen is produced in the process of laboratory preparation.

The changes in the contents of the amniotic fluid appear with the development of the skin and its adnexa and with the mucosal glands in the pharynx and oral cavity. Likewise do the loose cellular elements and amorphous and crystal-like admixtures appear in the amnion and simultaneously in the lumen of the auditory tube and of the middle ear space.

The physiological foreign bodies do not produce inflammatory reactions in the mucosa or in the underlying mesenchymal tissue. The exchange of water in the amnion serves as a clearing mechanism.

The formation and the shape of the tympanic cavity are determined by the growth of the middle ear cartilages, by the amount of amniotic fluid in the lumen, and by the contents of the intercellular fluid in the surrounding mesenchymal tissue.

With the growth of the potential cavity, the surface of the middle ear mucosa enlarges and produces polypoid excrescences. The polyp-like protrusions found in the middle ear cavity in the terminal period of uterine life or postnatally represent incompletely shrunken or unabsorbed portions of mesenchyme. They apparently are not of inflammatory origin.

During uterine life the lumen of the auditory tube remains permanently patent. Apparent restriction of the lumen or temporary occlusion during the development does not exist. The pseudo-occlusion appears in unevenly cut sections.

NYSTAGMUS ELECTRICALLY RECORDED

A Clinical Method

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EXAMINATION of the vestibular system is usually undertaken by the classical methods introduced by Bárány in 1907.[1] The deficiencies of these methods have recently been described by several authors (van Egmond, Groen, and Jongkees,[2] Groen and Jongkees [3] and Hulk [4]).

Egmond, Jongkees, and Groen introduced a new method of investigation called cupulometry. The principle of this method is the investigation of the after-sensation of turning and postrotatory nystagmus after well-defined decelerations from below the threshold. Cupulometry is of great value, but the recording of sensation alone gives the resultant of the function in all the vestibular pathways, including the cortex. Direct observation of the postrotatory nystagmus does not permit quantitative estimation apart from duration of nystagmus. A differential diagnosis of localization is therefore uncertain by means of this method. In our opinion, a quantitative investigation of the vestibular function involves registration of nystagmus.

Nystagmus has been exactly recorded by several authors. Ohm [5] in 1924 attached to the sclera of the eye small hooks carrying a pen which recorded on a kymograph. Buys and Rijlant [6] in 1939 used a pneumatic system. Dohlman [7] in 1935 attached a small mirror to the sclera and recorded nystagmus photographically. Eye movements have also been recorded by means of a motion picture camera.

Mechanical methods are uncomfortable for the patients and probably hinder the movements of the eyes. For optical recording it is necessary to have the eye illuminated, but nystagmus is inhibited by such illumination. None of these methods is adaptable to routine examinations.

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† Dr. Hertz died on Feb. 6, 1953.

From Sundby Hospital, Otological Department (Chief: Prof. Robert Lund), and Rigshospitalet, Neurological Department (Chief: Prof. Mogens Fog).

1. Bárány, R.: Physiologie und Pathologie (Funktions-Prüfung) des Bogengang-Apparates beim Menschen, Leipzig & Wien, F. Deuticke, 1907.
2. van Egmond, A. A. J.; Groen, J. J., and Jongkees, L. B. W.: J. Laryng. & Otol. **62**:63, 1948.
3. Groen, J. J., and Jongkees, L. B. W.: J. Physiol. **107**:1, 1948.
4. Hulk, J., and Jongkees, L. B. W.: J. Laryng. & Otol. **62**:70, 1948. Hulk, J.: Cupulometrie, Thesis, Utrecht, 1949.
5. Ohm, J., in Brunner, H.: Handbuch der Neurologie des Ohres, Vienna, Alexander Marburg, 1924, p. 1089.
6. Buys, E., and Rijlant, P.: Arch. internat. physiol. **49**:101, 1939.
7. Dohlman, G.: Acta oto-laryng. **23**:50, 1935.

Electrical registration was first described by Schott [8] in 1922 and later by Jung [9] in 1939. Jung utilized the corneal-retinal potential described by Du Bois-Reymond [10] about the middle of the last century.

Jung and Tönnies [11] in 1948 recorded the alterations of eye movements in the projection of the corneal-retinal potential picked up by electrodes attached to the face of the patient. By means of an amplifier and an electromagnetic mirror galvanometer the potentials were recorded on photographic paper in an electrocardiograph. Jung and Tönnies [11] recorded mostly postrotatory nystagmus, although rotatory nystagmus was recorded in some series in which the electrocardiograph was rotating with the patient. Glorig and Spring [12] in 1950 recorded caloric nystagmus by means of an electroencephalograph.

It has been our aim to devise a method for quantitative investigation of the sensitivity of the ampullar cristae, the function of the vestibular nuclei, the coordination of eye movements, and the sensation and after-sensation of turning. The method should be easily adaptable to routine examination of patients so that the diseases in the four levels mentioned could be localized. Rotation, in darkness to avoid fixation, is adequate for stimulation. Nystagmus registration must be independent of the rotation. The horizontal and vertical movements of the eyes must be separately recorded, and it should be possible to see at least the horizontal movements of each eye. Sensation of rotation must be recorded on the paper with the nystagmus, where also the angular speed of the chair is recorded in terms of degrees per second.[13] The acceleration must be easily reproducible and variable from below threshold.

TECHNIQUE

The apparatus consisted of a turning chair with an adjustable headpiece for the fixation of the head in different positions (Fig. 1). A black tent was fixed on the chair to exclude all light. Four slip rings were mounted on the chair with four carbon brushes corresponding to the four electrodes utilized in this method (Fig. 2). Through the slip rings the impulses picked up with lead electrodes fixed on the face with adhesive tape were led to a three-channel A. C. push-pull amplifying system driving three ink writers devised for electroencephalography. The amplifiers were modified from those described by Buchthal and Kaiser [13] in 1943. The amplifier had a time constant of one second. This was considered adequate for the purpose.

A fourth ink writer was used as an indicator pen. A commutator fixed on the shaft of the chair indicated every 60 degree turn, and by means of a fifth slip ring the patient's push-button signals were led to the same pen. The chair rotated on ball bearings. The rim of a bicycle wheel, 2 meters in circumference, was attached to the chair, and a 0.5 HP D. C. motor was attached by means of a spindle and a set of small wheels connected by a belt to the rim.

Special precautions were taken to ensure reproducible accelerations of the motor independent of the load. The motor was run off 220 volt A. C. mains. The field winding system and the armature of the motor were connected to two independent rectifiers, the armature through a variable transformer by means of which the voltage could be regulated from 0 to 220 volts. A resistance of 110 ohms was placed across the armature. By these means it was ensured that a

8. Schott, E.: Deutsches Arch. klin. Med. **140**:79, 1922.

9. Jung, R.: Klin. Wchnschr. **18**:21, 1939; Acta oto-laryng. **36**:199, 1948.

10. Du Bois-Reymond, E.: Untersuchungen über thierische Elektricität, Vol. 2, Berlin, G. Reimer, 1849, p. 256.

11. Jung, R., and Tönnies, J. F.: Klin. Wchnschr. **26**:513, 1948.

12. Glorig, A., and Spring, S.: Ann. Otol. Rhin. & Laryng. **59**:146, 1950.

13. Buchthal, F., and Kaiser, E.: Acta psychiat. et neurol. **18**:389, 1943. Buys, E.: Ann. oto-laryng. **4**:109, 1940.

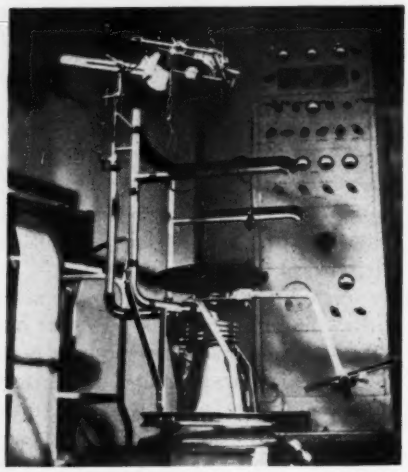

Fig. 1.—Turning chair, amplifier, and ink writer equipment. Slip rings and driving wheel are seen; headpiece is attached to chair.

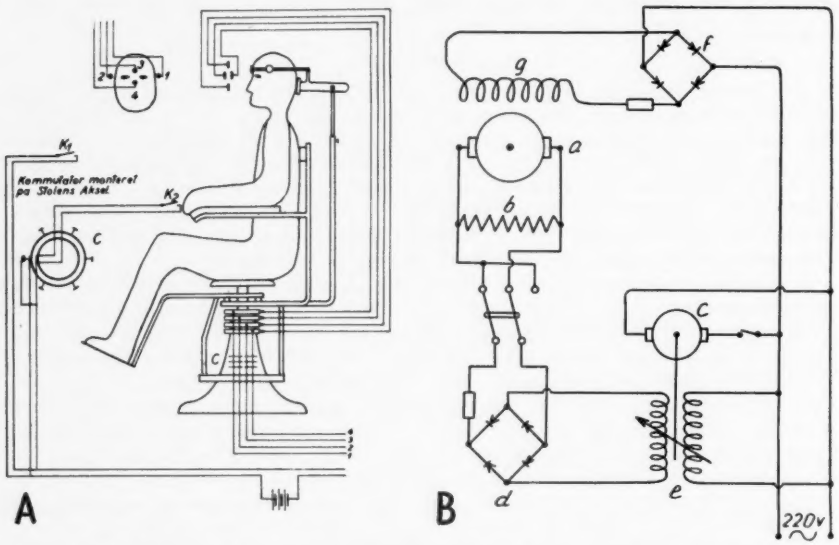

Fig. 2.—*A*, diagram of turning chair. From four electrodes on face of patient (Nos. 1 to 4) four leads go through four slip rings mounted on shaft of chair. Here is also mounted a commutator (*C*) for marking of 60 degree turn and a fifth slip ring for press button (K_2) for signaling of sensation of rotation. *B*, diagram of motor arrangement: *a*, anchor of direct current motor; *b*, field winding of same; *c*, resistance of 100 ohms across anchor; *d*, rectifier for anchor; *e*, rectifier for field winding; *f*, variable transformer; *g*, phonograph motor to drive variable transformer for constant acceleration.

certain position of the variable transformer always corresponded to a certain speed of the motor independent of the load. The motor was large compared with its load, which further ensured the stability of the system.

By means of a phonograph motor, with a constant speed and different gears, the variable transformer could be so maneuvered that various well-defined accelerations could be produced.

PROCEDURE

The patient was placed in the chair and his head was fixed in the adjustable headpiece so that the semicircular canals to be investigated were in the horizontal plane.

Four electrodes were placed on the face (Fig. 2). No. 1 was placed to the lateral corner of the left eye, No. 2 to the lateral corner of the right eye, No. 3 on the base of the nose between the eyes, and No. 4 on the tip of the nose. Electrodes 1, 2, and 3 were placed in a horizontal line. The skin was first cleansed with ether, and a small piece of the electrode paste used in electroencephalography was put under each electrode, the electrodes being fixed with adhesive tape. With some practice the electrodes could be placed in less than five minutes. To calibrate the amplitude of eye movements in degrees the patient faced a wall at a distance of 50 cm., and 28.8 cm. on the wall corresponded to an eye movement of 30 degrees. The speed of the paper was 3 cm. per second. The black tent was put over the patient's head, and the gear of the phonograph motor was adjusted to the desired acceleration.

The ink-writing pens were started just before the motor that drove the chair. The experiment was repeated with rotation in the opposite direction and without the tent for recording of optokinetic nystagmus. The coordination of the eye movements was estimated by investigating the ability of the patient to follow an object moving around in a circle in the periphery of the visual fields when the head was fixed (Jensen [14]).

PRELIMINARY RESULTS

Figure 3 *A* shows the vertical and the horizontal deviations of the eyes on 30 degree movement and the blink artifact. Muscle disturbances have a very high frequency and are easily recognizable from the eye movements proper. To avoid muscular disturbances it is important, however, to rotate in darkness and with open eyes. Figures 3 *B* and *C* show normal reaction on rotation. The threshold of each semicircular canal can be estimated separately and is normally about one degree per second [13] as described by Mach [15] and later confirmed by Dohlman,[7] Jung [9] and Groen and Jongkees.[3]

If the acceleration is kept constant in the single experiment, it is easily calculated from the record by measuring the interval between the markings of every 60 degree turn of the chair. For this purpose a special ruler was devised by engineer Edmund Kaiser of Copenhagen (Fig. 4). By placing the center of this ruler on a mark and adjusting the spiral line (*a*) to the previous marking the acceleration can be read directly in degrees.

Figure 3 *D* shows the eye movements when the eyes follow an object moving in a circle on the outer edges of the visual fields. The upper lines show the left and right horizontal movements, the lower line the vertical movements of both eyes. The deviations of the former are 90 degrees out of phase with the lower. The movements on circumduction in normal persons are even. The records are flat on maximum deviation, indicating that the eye axis moves in a rectangle with rounded corners, not in a circle.

14. Jensen, V. A.: Nord. med. **21**:580, 1944.

15. Mach, E.: Grundlinien der Lehre von den Bewegungsempfindungen, Vol. 4, Leipzig, W. Engelmann, 1875.

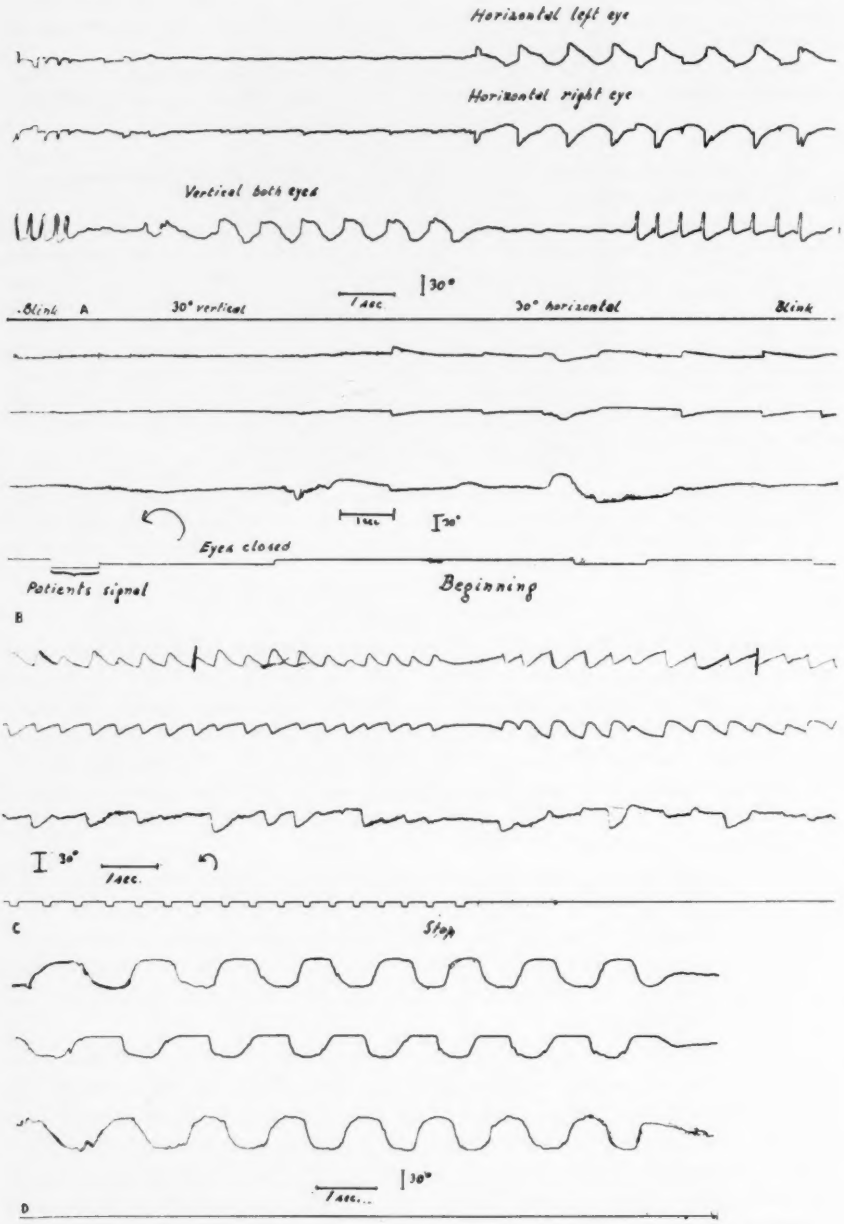

Fig. 3.—*A*, 30 degree calibration; horizontal and vertical movements and blink artifacts. *B* and *C*, normal record; acceleration 2 degrees per second. *D*, circular movements of eyes; normal coordinated eye movements.

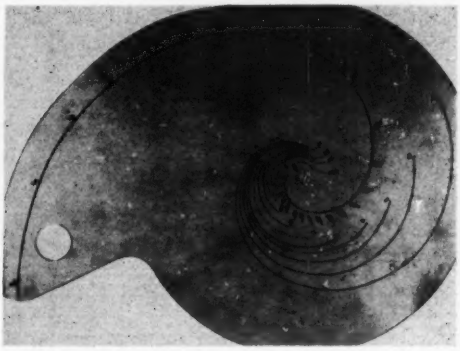

Fig. 4.—"Ruler" for calculating acceleration. Spiral line (*a*) and hole in the center are adjusted to beginning of two successive 60 degree-markings on record; acceleration can be read on smaller spiral lines 1 to 20 degrees per second by estimating which of these lines is nearest beginning of next 60 degree mark.

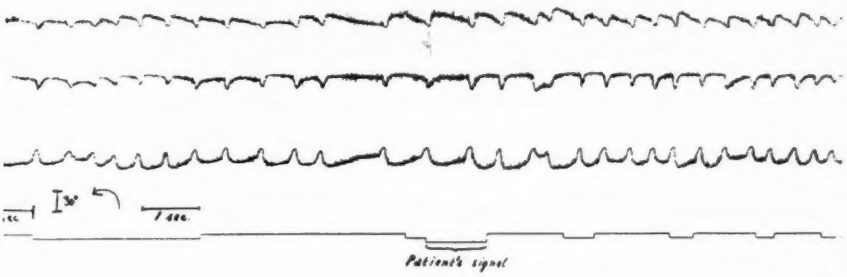

Fig. 5.—Record from patient with acute labyrinthitis and destruction of right labyrinth of one month's duration. Increase of left and vertical nystagmus on counterclockwise rotation.

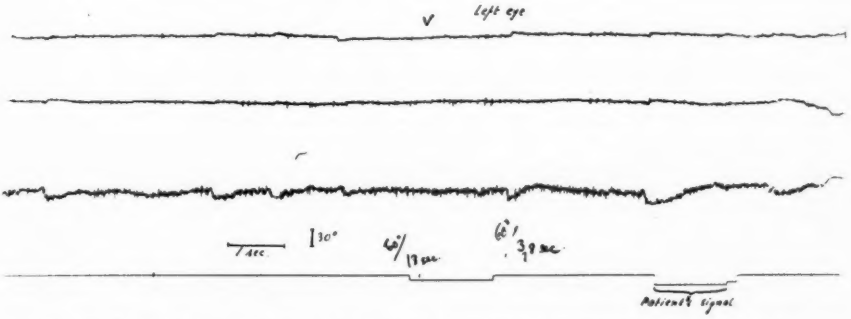

Fig. 6.—Record taken three months after left Cawthorne's operation. Nystagmus is seen at an acceleration of less than 2 degrees per second, but amplitudes are small.

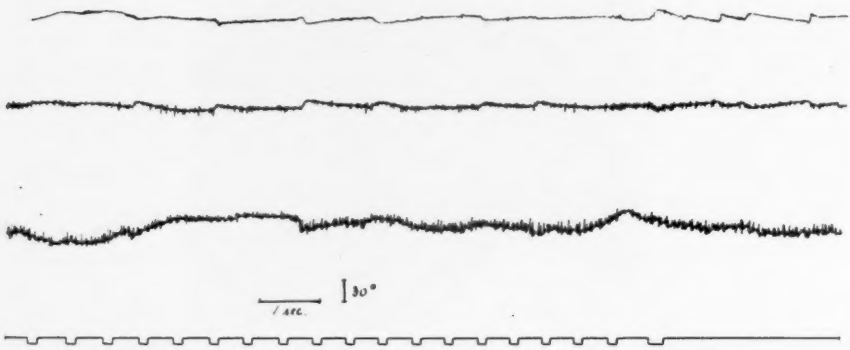

Fig. 7.—Diffuse arteriosclerotic lesion of brain stem. Threshold is increased; nystagmus is irregular, and amplitudes different and varying in two eyes.

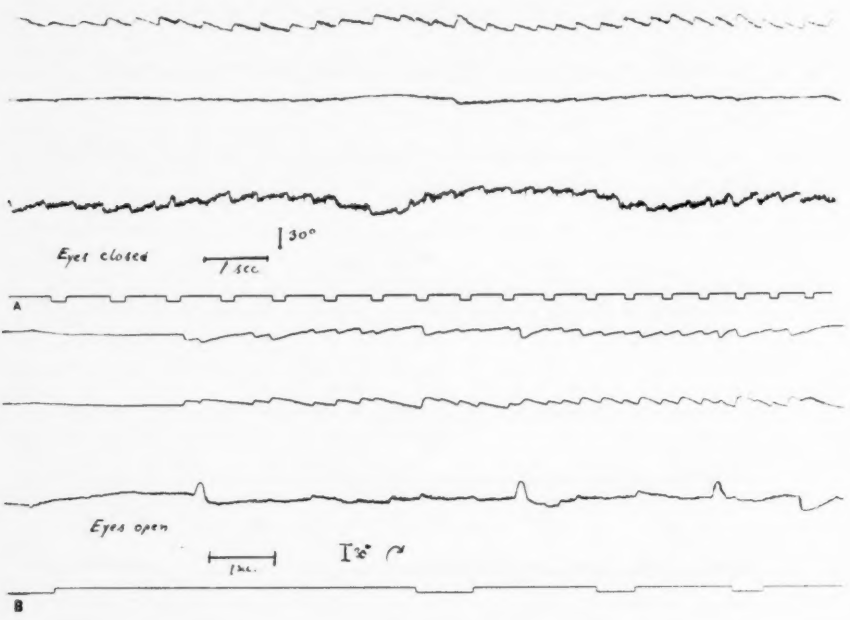

Fig. 8.—*A*, brain stem thrombosis. Threshold is almost normal, but nystagmus is seen only in left eye when patient is rotated with eyes closed.

B, same patient rotated with eyes open. Nystagmus is now equal in the two eyes.

Figure 5 shows the nystagmogram from a patient with acute labyrinthitis of 30 days' duration, with destruction of the right labyrinth. Already before rotation, a combined horizontal-vertical nystagmus is seen. On counterclockwise rotation, the nystagmus to the left is increased, which shows the preponderance of the left labyrinth.

Figure 6 shows the nystagmogram of a patient taken three months after a left-sided Cawthorne's operation. Even on low acceleration, nystagmus is clearly visualized shortly after the onset of rotation, indicating that the threshold is normal, or almost normal.

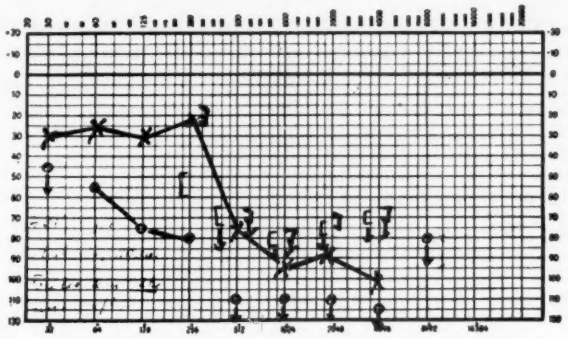

Fig. 9.—Audiogram from patient with brain stem thrombosis.

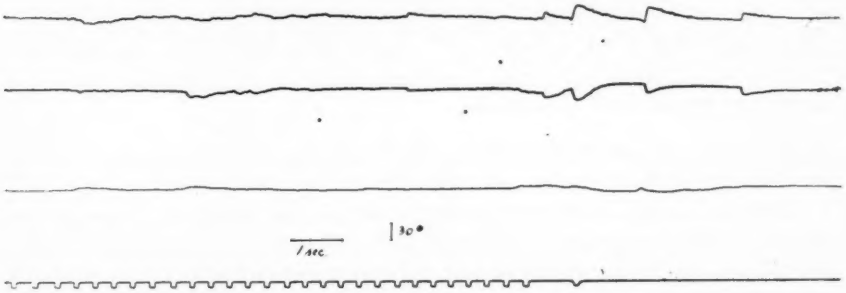

Fig. 10.—Nystagmogram of patient seven months after treatment with dihydrostreptomycin. Increased threshold; irregular nystagmus with low amplitude.

Figure 7 shows the nystagmogram of a patient with an arteriosclerotic lesion of the brain stem and vertigo. It is characteristic that nystagmus is irregular, that the amplitudes are small and different in the two eyes, and that the threshold seems unequal on clockwise and counterclockwise rotation.

Figure 8 shows the record from a patient with a brain stem thrombosis. The onset was sudden and showed the symptoms described below.

The patient, a 63-year-old man, suddenly became unconscious and remained so for well over half an hour. On waking he was unable to understand speech and had vertigo. Examination showed slight instability of the ocular movements and right-sided Babinski reflex. Audiometry (Fig. 9) showed an almost complete loss of hearing from 200 cps upwards. There were no ocular palsies. The nystagmogram showed a normal threshold, but there was only nystagmus

of the left eye on rotation with closed eyes both clockwise and counterclockwise (Fig. 8*A*). On rotation with open eyes (optokinetic) the deviations were normal in both eyes (Fig. 8*B*). In this case, the nystagmogram gave the localization of the lesion in the brain stem between the vestibular nucleus and the nucleus of the sixth nerve in the longitudinal medial fasciculus.

Figure 10 shows the nystagmogram of a patient with severe vertigo seven months after treatment with dihydrostreptomycin. The record shows an increased threshold. The nystagmus was irregular, the amplitude low and different in the two eyes.

Figure 11 shows the circumduction movements of the eyes in a patient who was still giddy after treatment with streptomycin five years before the investigation.

In our opinion, the fact that on circumduction there was incoordination of the eye movements which did not involve the vestibular system proves that there is an essential central (brain stem) lesion in streptomycin intoxication. This corresponds well with the results of animal experiments (Christensen, Hertz, Riskaer, and Vraa-Jensen [16] in 1950 and 1951). The recording of the instability of the eye move-

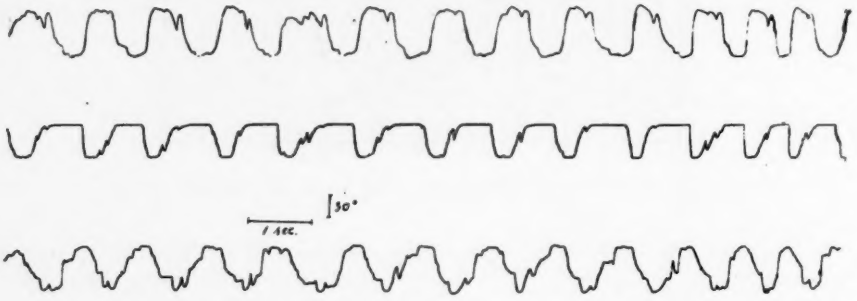

Fig. 11.—Record of circular movements of eyes showing severe incoordination of the ocular muscles after treatment with streptomycin.

ments in these patients is an important objective finding and gives the key to understanding complaints of vertigo years after the streptomycin treatment.

In all the patients investigated the sensation and after-sensation of turning were recorded. The correlation between subjective sensations and nystagmus is under examination, but even from the present material it may be deduced that the recording of the sensations alone in the cases hitherto examined would have given results that were difficult to interpret.

In this paper, only a few examples have been presented in which the nystagmogram seemed to have been of diagnostic value, but it is our intention to produce normal material that can be statistically treated. With knowledge of the normal limits, various types of damage to the vestibular system should be investigated, and the results should be compared with those obtained by registration in a similar way of other parts of the vestibular and cerebellar function, such as, for example, the coordination of muscles of the limbs and the body. It is our opinion that this is an important field for cooperation between the otologists and the neurologists for a greater understanding of the symptoms of vertigo and giddiness.

16. Christensen, E.; Hertz, H.; Riskær, N., and Vraa-Jensen, G.: Acta pharmacol. et toxicol. **6**:201, 1950; Ann. Otol. Rhin. & Laryng. **60**:343, 1951.

SUMMARY

A short survey is given of methods in use for the clinical examination of the vestibular system. At present it is impossible to distinguish between lesions in various parts of the vestibular pathways: the peripheral vestibular organ, the central vestibular nuclei, the pathways between these and the ocular nuclei, the coordination system of ocular movements, and the sensation of turning.

A method for the electrical recording of nystagmus and voluntary eye movements, and of the sensation of turning in well-defined accelerations is described. Finally some examples are given of results obtained.

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GASTROSCOPY FOR THE OTOLARYNGOLOGIST

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IT IS A fact that clinical gastroscopy has made a good deal of advance in recent years as an endoscopic procedure for exploration of gastric conditions and, from the otolaryngological viewpoint, as an extension of esophagoscopy as a means to determine esophagogastric pathology and facilitate the technique of biopsies and removal of foreign bodies. It may seem unbelievable to some that gastroscopy is an older procedure than use of the x-ray; but it has not developed or evolved the elaborate paraphernalia or instrumentation of the x-ray until recently. Why? Although endoscopic study of the gastrium is naturally associated with instrumentation in the esophagus, the medical profession was slow with improving and designing the proper instruments until recently.

Historically, the period 1759 to 1842 marks the beginning of our knowledge concerning early attempts at peroral endoscopy, according to Barowsky,[1] who freely quotes Schindler. It is believed that such efforts were made by Bozzini in Germany, Sequales in France, and Avery in England during this period. It is also believed by some that the first persons to attempt the introduction of a rigid straight instrument down the throat into the esophagus were not surgeons at all but entertaining sword swallowers. Kussmaul of Germany (Freiburg, 1868), who reasoned in a similar way, employed a sword swallower for his experiment to introduce a straight tube into the esophagus and stomach. He wanted to observe the mucous membrane of the stomach in a living subject. But endoscopic examination of the esophagus and stomach were then hardly possible because of the inadequacy of technical equipment and the little electric bulbs which are so necessary for scientific observation, identification of landmarks, and study.

Later in the 19th century Mikulicz of Vienna attempted to improve gastroscopy by a simple arrangement of a lighting device and an air outlet in his tube in order to inflate the stomach. While a number of other investigators and clinicians have followed the system of Mikulicz, and while numerous theories and ideas have been proposed to improve or establish a scientific method for gastroscopy, the entire idea of the work as it was then practiced had to be abandoned. The instruments, the method of illumination, the hazards to the patients, and the problem of anesthesia stood in the way of success. It is not, therefore, difficult to imagine that with such gloomy reports most of our pioneers of peroral endoscopy, especially gastroscopy, became discouraged and were willing to attempt any sort of method in order to contribute something practical to this work. It was then decided by a very small group of men, probably by those who were experienced in the techniques of

1. Barowsky, H.: Gastroscopy, Rev. Gastroenterol. **13**:25 (Jan-Feb.) 1946.

bronchoscopy and esophagoscopy, to employ the rigid tube in gastroscopy. The present-day open-tube gastroscope is merely a longer electric-lighted tube (usually from about 53 to 70 cm.) than the esophagoscope (about 45 or 49 cm.); otherwise than in length, it has the same shape and form of construction as the esophagoscope.

I use a rigid gastroscope about 58 cm. in length with a 10-mm. lumen, an inflation rubber bulb, a window plug with two stopcocks, and an eyepiece (lens). This instrument is a modification of the Jackson esophagoscope, or peroral gastroscope, and the Tucker esophagogastroscope; the original idea was mine, and it was carried out with the assistance of E. J. Houghteling, of the American Optical Company. The instrument is manufactured by the Electro-Surgical Instrument Company of Rochester, N. Y. It should be emphasized that the rigid instrument is a valuable adjunct in the diagnosis of gastric pathology. No one pretends that gastric examination with this type of instrument could do away with other methods of diagnosis. Before doing a gastroscopy it is of utmost importance to have a complete history of the patient and to make an x-ray observation, a physical check-up, a gastric analysis, and an esophagoscopic examination. In some cases additional laboratory and bronchoscopic procedures may be necessary—as in cases of hemoptysis—and in many instances a diagnosis is arrived at with such procedures without gastroscopy. In many cases, however, these procedures will hardly reveal the principle underlying gastric disease, and hence the role which gastroscopy may play as a dramatic contribution to the entire diagnostic picture. Before proceeding it would be well to recall that a discussion of gastroscopy would not be complete without mentioning the two other types of instruments besides the rigid one: the Schindler-Wolf flexible gastroscope (designed by Schindler and manufactured by Wolf) and the new improved type of flexible operating gastroscope (manufactured by American Cystoscope Makers of New York). Both types of gastroscope contain a series of lenses permitting inspection of a large portion of an illuminated and inflated stomach.

From a review of recent literature on indications and contraindications for gastroscopy, it is learned that all authorities agree that the method should be employed as a technique supplementary to x-ray work, when the x-ray interpretation of gastric lesions may require additional corroboration, in cases of epigastric pain in which there is a tendency on the part of the physician to class the condition as psychosomatic or the patient as a hypochondriac although gastroscopic study might reveal chronic gastritis, ulcers, foreign bodies, benign tumors, cancer, or other lesions causing the hemoptysis or hematemesis.

In connection with hemoptysis, as I stated in a previous paper on the subject,[2] there have been innumerable cases in which the cause of the trouble was not easily discovered and diagnosed. It is well known that when a patient with hemoptysis presents himself to a physician for examination or help the physician usually calls to mind the two formidable diseases, carcinoma and tuberculosis of the lung. In fact, there is very little difference in the symptoms of these two diseases. Another reminder: Blood in the mouth, whether coughed up as streaks in mucus, as pink saliva, or as hemorrhage, always presents an immediate problem, demanding atten-

2. Shanks, J.: Bronchoscopy and Hemoptysis, Eye, Ear, Nose & Throat Month. **31**:492 (Sept.) 1952.

tion for quick solution of its etiological factor. Hence the painstaking examination with mirrors in posterior rhinoscopy and indirect laryngoscopy and direct examination with the laryngoscope, bronchoscope, esophagoscope—and gastroscope.

Roentgenoscopic study of the esophagus as well as the gastrium is extremely valuable in giving a clue as to the contraindication. A foreign body, stricture, tumor, or diverticulum or varices in the esophagus will, of course, prohibit the use of this technique. Other contraindications are any neoplasm or stricture obstructing the cardia and any debilitating pulmonary or cardiac conditions (coronary, cardiac decompensation, advanced hypertension, and so on).

TECHNIQUE OF ESOPHAGOGASTROSCOPY

The technique of gastroscopic examination is not easy to describe on paper or in such a way that a beginner may read about the various steps and then proceed with a rigid open-end metal tube with safety. Every portion of the pharynx, hypopharynx, and esophagus must be observed under direct vision in order to find the lumen of the esophagus and follow the instrument through the cardia into the stomach. This procedure requires a good deal of study and experimental work on the dog followed by work on many patients before the necessary skill is acquired. The average surgeon who is skilled in bronchoscopy, laryngoscopy, and esophagoscopy could, I believe, easily master the technique of gastroscopy. In fact, the procedure is similar to esophagoscopy. It should be emphasized that when the instrument is correctly introduced into the esophagus every portion of its lumen may be observed directly until the cardia is reached; on introducing the instrument through the cardia an important part of the stomach can likewise be observed. Such observations contributed much to the accuracy of diagnosis of lesions within the esophagus and stomach. Thus, gastroscopy, which may appear to be a very difficult procedure to the average inexperienced assistant or observer, is really simple if the correct method is carried out. The following points must be observed:

1. Diet. The patient is told to have a very light meal the evening before the procedure and not to eat or drink after that meal. He should have no breakfast; he comes to the hospital with an empty stomach.

2. Premedication. Some physicians question the benefits derived from the use of medicinal preparations prior to instrumentation. However, for some of the nervous persons with that characteristic apprehensive look I have found that pentobarbital (Nembutal) sodium, ¾ grain or 1 grain given orally about 45 minutes before the procedure, is very effective. Some clinicians advocate opiates or meperidine (Demerol), medication entirely too farfetched and unnecessary.

3. Examining Room. The average examining room or tonsillectomy room with facilities for being darkened is adequate.

4. Preexamination: In the preexamination period the possibility of intubation and the emptying of gastric contents must not be forgotten. Visualization of the stomach through endoscopy is through an air medium; liquid will always obscure the view. In addition, fluid may cause the observer to receive an entirely false picture of the case.

5. Anesthesia. A 2% solution of tetracaine (Pontocaine) hydrochloride is the anesthetic par excellence. Simple spraying or swabbing the base of the tongue, pharynx, laryngopharynx, and pyriform sinus will produce adequate anesthesia. It

generally takes 10 minutes to bring about the maximum desired effect, and the anesthesia lasts 15 minutes, more or less. Some endoscopists insert a rubber tube or catheter into the cervical esophagus and inject through it more of the tetracaine solution—a method which I believe to be unnecessary. Occasionally, of course, the patient may insist on general anesthesia, and one of the best agents is a 2.5% solution of thiopental (Pentothal) sodium. About 5 to 8 cc. is injected intravenously. It is given very slowly, the injection taking about half a minute. The patient is told to relax and count from 1 to about 15 or even 20 before the narcosis sets in; meanwhile the needle is kept inserted in order to inject additional thiopental sodium (2, 3, or 4 cc.) if necessary. In this connection, a laryngeal spasm is a serious complication and may occur. Also, an overdose of this anesthetic agent is a respiratory depressant that can bring on respiratory arrest with the usual symptoms of obvious depression of respiration and alarming cyanosis. Should this occur one naturally resorts to the following swift measures: (1) administration of stimulants (respiratory and cardiac); (2) artificial respiration, and (3) administration of oxygen. All equipment and drugs must be prepared in advance of all procedures. Some gastroscopists and observers give the following three reasons for the use of thiopental sodium for general anesthesia in gastroscopy:

1. By relaxing the masseter muscle, which in turn causes the jaw to drop, the surgeon is enabled to enter the esophagus and stomach in a more facile way.

2. The patient's position on the table makes it comparatively easy for the anesthetist to use the intravenous method of anesthesia.

3. The anesthesia can be of short duration, with rapid recovery of the patient.

In reviewing the literature on gastroscopy one is impressed by the valuable reprint "Gastroscopy" from *Review of Gastroenterology* by Barowsky, of New York, who gives about 31 references. His notes are valuable to the student and gastroscopist alike because of his short descriptive text on the normal stomach, gastric movements, parts of the stomach, the proper method of examining the interior of the stomach, gastroscopic photography, the blind spots, methods for overcoming the blind spots, and the clinical evaluation of gastroscopy (including gastric pathology), but his short and fine descriptions on gastroscopy as an aid to roentgen interpretation, gastroscopic evaluation of malignant tumors, types of malignant lesions of the stomach, gastric ulcers, postoperative stomach, and open-tube gastroscope are especially enlightening. While the statements previously quoted in connection with endoscopic work in the stomach are illustrative and important, the gastroscopist has still to think of the essential points relating to air in the stomach, characteristics of the normal stomach, important points in gastric pathology, use of the operating gastroscope, and biopsies.

From reports on the subject and experience in a number of cases it is learned that inflation of the stomach by air generally produces no distress or dangerous consequences to the patient. However, if a prolonged examination is required the patient does complain of a vague abdominal irritation, a sensation due to excessive air distention of the bowels.

One of the commonest phases in the advanced study of gastroscopy (with rigid or flexible gastroscope) is viewing and identifying the tissues of the stomach upon entering through the cardia. Upon entering the stomach the viewer should attempt to perceive its anterior wall. He does this by pointing the handle of the instrument

at an imaginary 9 o'clock in about a direct line with the nose of the patient. To begin with nothing is distinguished, but as air is blown into the gastrium a dark-red circular zone suddenly appears. Gradually, with more inflation by means of the rubber bulb, a definite picture of the mucous membrane of the stomach will be visible. The operator will soon learn that an empty, collapsed stomach presents numerous longitudinal folds, or rugae, which disappear as inflation advances; he will observe that the gastric mucosa has a rich blood supply, with a rich capillary network, and has a distinct orange-red color. He will observe the fine cord-like rugae on the anterior wall, on the greater curvature, and on the posterior wall. In pathological conditions these cords may be hypertrophied, distorted, or entirely absent. As the examination proceeds an important phase worth remembering is: Regardless of how well the stomach has been emptied a certain amount of fluid will remain in it—the "mucous lake"—and this remnant will increase during examination and may interfere with the procedure.

A most interesting aspect of gastroscopy, aside from a knowledge of the gross anatomy, physiology, and pathology, is the way the operator views and divides the parts of the stomach into sections. For instance, to facilitate study of the stomach as viewed from a lighted tube, the various parts are given specific names, such as antrum, or pyloric antrum, and body. The portions are subdivided into angulus, or incisura angularis; pylorus; greater curvature; lesser curvature; posterior wall; anterior wall; fornix, or fundus, and cardia. Having all these landmarks in mind, the operator proceeds with the examination.

When the instrument is carefully advanced into the pharynx, laryngopharynx, and cervical esophagus past the cricopharyngeus muscle, inspection of the esophagus is generally easy as far as the cardia. Secretion is removed by suction and swabbing; usually suction will suffice. The esophagus in most cases inclines anteriorly toward the left as it passes the cardia into the stomach, and it may not be so easy to pass a rigid metal instrument into the stomach. When the instrument is advanced to so-called Depth 1 (greatest depth) a semilunar view makes its appearance (the angulus). This is an important landmark, as it is thought of as the dividing line between the antrum and body of the stomach. As the examination is continued, the antrum comes into view as a tubular cavity distal to the angulus. The mucosa of the antrum is naturally darker than the rest of the stomach (owing to light reflection). Occasionally one observes the pylorus appearing as a small dark hole. One of the commonest and most troublesome phases in gastroscopy is inability to view a great portion of the lesser curvature of the antrum, the "blind spot," a most frequent site of pathological processes. The so-called body designates practically the entire stomach proximal to the angulus; the cardia is perceived just before withdrawal of the gastroscope, especially with an open-tube rigid instrument.

It has been a recognized fact that in order to have a clear picture of the mechanics involved in this type of endoscopy, the operator must learn not only the technique of the instrument but the refinement of the landmarks and what is called "Depth 1," "Depth 2," and "Depth 3." When the stomach is examined with the flexible instrument at "Depth 1" the angulus, antrum, and pylorus are seen. Observations are made of the greater and lesser curvatures and of both walls. As the instrument is withdrawn into the middle portion of the stomach

or just to a point where the angulus disappears from view, the point of observation is termed "Depth 2." The next position, or level, at which the interior of the gastrium is viewed is immediately below the cardia, at "Depth 3."

Besides the important relations of the phases in gastroscopy enumerated, brief mention should be made of the use of gastroscopic biopsy for the diagnosis of lymphoma, carcinoma, gastritis, and the psychosomatic conditions. Edward B. Benedict [3] contributed a study on the differential diagnosis of benign and malignant lesions of the stomach by means of the flexible operating gastroscope, an interesting and worth-while contribution because it was undertaken with the most recent of the new additions to the armamentarium. He states that positive evidence of lymphoma is better than negative evidence; that positive results of gastroscopic biopsy for carcinoma may clinch an otherwise doubtful diagnosis; that a positive biopsy showing sarcoma is helpful and irrefutable (a negative biopsy does not exclude sarcoma), and that a biopsy showing adenomatous polyp, fibromyoma, or neurofibroma does not exclude the possibility of malignant change in areas of the tumor not included in the biopsy. The chief value of such a biopsy is to confirm a clinical roentgenologic, and gastroscopic impression of benign tumor in a patient who is a poor surgical risk or who will not consider surgery for a probably benign lesion.

In his discussion and conclusions on gastritis, gastric ulcer, and biopsies in connection with the operating gastroscope, he states that present knowledge of gastritis is limited. The operating instrument is providing the means of correlating the clinical, roentgenologic, gastroscopic, and pathological findings in gastritis. A biopsy specimen from the edge of a gastric ulcer does not assure its benignity. The opposite edge may be malignant. Furthermore, difficulties may be encountered in attempting biopsy of a gastric ulcer, namely (1) danger of perforation and (2) difficulty of directing the biopsy forceps to the exact spot desired.

CONCLUSIONS

Attention is called to several outstanding features in connection with gastroscopy.

Mastering the technique with the rigid or flexible instrument through study, observation, and clinical work is especially suited to the otolaryngologist with a knack for bronchoscopy and esophagoscopy.

Seemingly trivial details in anesthesia, instrumentation, and the work of assistants should never be left to chance; a careful check and proper preparation are things to be depended upon.

Cooperation with the roentgenologist is important.

3109½ N. Lincoln Ave. (after Aug. 1, 1953: 3325 N. Lincoln Ave.)

3. Benedict, E. B.: Symposium on Gastric Neoplasms: Differential Diagnosis of Benign and Malignant Lesions of the Stomach by Means of the Flexible Operating Gastroscope, Gastroenterology **14**:275 (Feb.) 1950.

PARENTAL EVALUATION OF TONSIL AND ADENOID REMOVAL

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THIS PAPER is a preliminary report of parental opinion relative to the success or failure of adenotonsillectomy. The study was undertaken as a critical evaluation of surgical efficiency in carefully selected cases. Many surveys have been done over the years with indifferent results. Despite many variables that may be involved in this problem, observance of two basic principles should provide favorable postoperative results in any series of cases reviewed. These principles are: (1) careful selection of patients and (2) good surgical technique.

Within the past decade the need for adenotonsillectomy in children has been minimized. An analysis would probably show public pressure the major cause rather than a change in competent professional opinion. Because of a variety of information and misinformation concerning this subject, it is small wonder that parents are sometimes reluctant to accept a decision demanding surgery. In an excellent review of tonsillectomy, Boies [1] clearly outlines the cause for parental concern, which includes: (1) the indications, (2) the probable inadequacy of the operation, and (3) the associated morbidity and even mortality. He believes that with a trained laryngologist none of these aspects should provide a valid contraindication. Although control of infection is greatly facilitated by the antibiotic and chemotherapeutic aids available, this temporary therapy cannot and should not supplant surgery in many instances.

In part, the medical profession is responsible; in part, the press. Certainly the parent cannot be blamed for the existing confusion. Not many years ago it became almost a routine procedure with some members of the medical profession to recommend tonsillectomy or adenotonsillectomy at a given age regardless of adequate indications. The public accepted and actually demanded this type of medical care. These "prophylactic" operations have been repudiated by Lederer,[2] Meyer,[3] and others. It is still disheartening to read and see pictured in the press accounts of entire families undergoing mass removal of the tonsils and adenoids. Constructive criticism has all but eliminated this abuse, but, as a result of unjustified surgery, the integrity of the medical profession has suffered. It is also recognized that any surgical procedure will fall into disrepute if basic principles are abandoned. This

From the Department of Otolaryngology, Carle Memorial Hospital and Carle Hospital Clinic.

1. Boies, L. R.: Tonsillectomy in the United States, Ann. Otol. Rhin. & Laryng. **59**:602, 1950.

2. Lederer, F. L., and Grossman, A. A.: The Otolaryngologist Looks at the Tonsil and Adenoid Problem, Eye, Ear, Nose & Throat Month. **28**:577, 1949.

3. Meyer, O.: The Eliminating Function of the Tonsils, Eye, Ear, Nose & Throat. Month. **29**:140, 1950.

situation has happened to the tonsil and adenoid operation, and there is ample evidence daily in an otolaryngological practice. Thus the surgeon has contributed his part in molding public opinion.

Pseudoscientific medical articles are very popular in the public press. The newspaper and magazine editors recognize and exploit the public interest. Some of the information is presented and unfortunately accepted as an established fact although it may simply represent an equivocal opinion. The most recent example is the controversy over the relationship of nose and throat surgery in regard to poliomyelitis. Some of the present studies indicate that the bulbar type of poliomyelitis may occur more frequently in tonsillectomized patients; but no conclusive evidence has been presented to indicate an increased susceptibility. The well-read reputable surgeon is aware of these opinions and will avoid this type of surgery when conditions warrant. On the other hand, the parent is confused by the jumble of "authoritative" statements, and as the result of promiscuous publicity, fear and indecision are created entirely disproportionate to the known facts. Thus a combination of parental apprehension and even skepticism places the prospective surgeon in an unenviable position. A good reputation plus skill in eliciting the patients' confidence will resolve most objections. Resistance to properly advised surgery means that some children will be denied the opportunity for better health.

The elaborate program throughout the school systems of today for the detection of hearing impairment is an excellent example of preventive medicine at its best. If proper therapy is denied after hearing defects are discovered, the program will lose its value. Corrective therapy many times will require surgical removal of the adenoids, tonsils, or both. It is imperative that for this and other reasons an intelligent perspective concerning the value of this type of surgery be developed for the parent. An ideal approach should be to publish the impressions gained by parents whose children have undergone adenotonsillectomy. The parents' opinion relative to the postoperative health of the children should serve as a solid basis for evaluation.

For ease of statistical handling in this preliminary survey, an even 100 reasonably completed questionnaires were sought. Of 134 inquiries, 104 were returned. Four were incomplete and could not be evaluated, leaving 100 for analysis. The patients comprised two separate chronologically consecutive groups. The postoperative time interval was 3½ to 4½ years in 90 cases and 2 to 2½ years in 10 cases. The age distribution follows:

2-3 yr., 3	5-6 yr., 23	8- 9 yr., 3
3-4 yr., 16	6-7 yr., 18	9-10 yr., 4
4-5 yr., 20	7-8 yr., 10	10-13 yr., 3
39	51	10

Of the children, 39% were less than 5 years of age. This relatively high percentage of younger children is at variance with some expressed opinions. Although Gale [4] admits that no convincing statistical evaluation of the effects of tonsillectomy has been made, he nevertheless states that tonsillectomy should rarely be done before the age of 5 years. No statistical information is given to support this viewpoint. When "prophylactic" removal of the adenoids, tonsils, or both was in vogue, the

4. Gale, A. H.: Pros and Cons on Tonsillectomy, Brit. M. J. **1**:133, 1951

age of the child was the deciding factor. With the abandonment of this approach, it is illogical to allow an arbitrary age limit to outweight other valid indications.

In some instances a failure to answer all questions completely gives rise to apparent arithmetical discrepancies in the following tabulations.

QUESTIONS AND ANSWERS

Question 1.—Was the operation beneficial from the standpoint of:

	Total Answers	Yes	No
(1) Increased resistance to infection?	92	78	14
(2) General well-being?	91	80	11
(3) Improved appetite?	79	59	20

Among 262 answers of a possible 300, a favorable response was given in 83%. Even if the possible 38 additional answers were all unfavorable, the over-all percentage would still be 72% favorable.

Question II.—Since surgery is any difference noted in:

	Total Answers	More	Less	Same
(1) Number of common colds?	100	2	66	32
(2) Severity of common colds?	91	2	71	18
(3) Duration of common colds?	85	2	58	25
	276	6	195	75

Although adenotonsillectomy is not recommended primarily to reduce the incidence or severity of the common cold, parental opinion as indicated by 276 of a possible 300 answers showed that 70% of the children operated on withstood this infection more readily. The additional 24 possible answers, even if all unfavorable, would reduce the favorable response by only 5%.

Question III.—If any of the following conditions was present before surgery, please indicate the appropriate answer:

	Total Answers	Cured	Improved	Unimproved
(1) Mouth breathing	47	19	22	6
(2) Swollen neck glands	45	16	28	1
(3) Noisy breathing at night	49	21	24	4
(4) Restlessness at night	36	9	20	7
(5) Constant nasal discharge in winter or year round	30	9	18	3
(6) Cough	26	8	14	4
		82	126	
	233	208		25

It should be noted that in 100 cases, objective findings of upper respiratory obstruction and infection were discernible to the parent many times. Of 233 clinically significant abnormalities, 208, or 89%, were relieved by surgery.

Question IV.—If hearing impairment was one of the indications for surgery, is the hearing now grossly:

Normal	Improved	Unimproved	Worse	Total Answers
12	13	3	0	28

An improvement in 25 of 28 cases of hearing loss is considered a very satisfactory result. This figure does not take into consideration those patients who may have had a subclinical hearing loss detectible only by detailed otological examination.

Question V (a).—

	Yes		Yes	No
Was your child subject to ear pain before surgery?	45	After?	11	34
Was your child subject to ear infections with discharge?	22	After?	8	14
	67		19	48

A presumptive diagnosis of otitis media can be made in the presence of recurrent aural pain associated with an upper respiratory infection. This would indicate a high incidence of middle-ear infection in the series studied. Complete relief of otolgia was experienced in 34 of 45 children; of aural discharge, in 14 of 22.

Question V (b).—If the patient had postoperative complaints of otalgia or aural discharge, the parents were asked, since surgery is any difference noted in:

	More	Less	Some	Total
(1) Frequency of pain or discharge?	0	16	2	18
(2) Severity of pain or discharge?	1	13	3	17
(3) Duration of pain or discharge?	2	11	2	15

Practically all the 19 patients still subject to either pain or aural discharge were less likely to have severe symptoms.

Question VI (a).—From a psychological standpoint, do you think your child was emotionally upset by his (or her) hospital and surgical experience?

Total answers, 95	Severely, 5	Slightly, 24
	Moderately, 7	No effect, 59
	12	83

In a review of the 12 cases in which there were moderate to severe reactions, additional factors were uncovered in 10 to account for the degree of upset. The most outstanding example was that of a child who had a circumcision along with an adenotonsillectomy. He was markedly affected for a short time, whereas his brother, who had previously undergone the tonsil operation, had had no reaction. Two children were subjected to anesthesia twice because of postoperative bleeding, one on the day of surgery and the other on the sixth postoperative day. Because two children were subject to "night terrors," the parents classified their reaction as moderate. Memory of previous surgery was felt to be partially responsible for another child's disturbance. Complete lack of cooperation was present in two children and was noted in the office as well as the hospital. It is probable that in two cases an extremely tense attitude on the part of the mother was reflected in the behavior of the child. Rectal instillation of pentobarbital (Nembutal, Abbott) was used preoperatively in this series, but the sedative effect was inconstant. Within the past several years, rectal instillation of thiopental (Pentothal) has been substituted, with more nearly predictable results. All patients have their parents at the bedside during the day of operation. The presence of parents seems to be of value in preventing psychological trauma.

Question VI (b).—In reference to the emotional upset, do you feel that this reaction was temporary or permanent?

Total Answers, 36	(severe, 5;	moderate, 7;	slight, 24)
Permanent, 3	Temporary, 31	Unspecified, 2	

Of the three cases in which the effect was termed permanent, the reaction had initially been classified as slight in one and as moderate in two. No explanatory remarks defining the character of the permanent reaction were included in the parents' report. A check of the histories disclosed an explanation in one of the cases. The child, who had been considered moderately and permanently upset by his surgical experience, was given a psychological interview three years post-operatively. The opinion of this study indicated that the child was under pressure from home to achieve, and his response was refusal to attempt different tasks for fear of failure.

COMMENT

The majority of these patients were referred for surgery after evaluation by the pediatrician. The referring physician is an equal partner in the prediction of good results. Without the careful consideration given to each individual case by Dr. James B. Gillespie, chief of the department of pediatrics, and his colleagues, the overwhelmingly favorable results would not have been achieved.

This preliminary survey indicates an intense parental interest and cooperation. Because of the need for additional data on the subject of adenotonsillectomy, a more detailed program of clinical research using this approach has been formulated.

SUMMARY

Parents' opinions based upon objective findings were obtained in 100 cases of adenotonsillectomy in children.

The over-all favorable results recorded in this survey should be easily duplicated provided careful selection of patients and good surgical technique are observed. Faith in this type of surgery may thus be reestablished.

IMPROVEMENT OF LOW-TONE DEAFNESS AND TINNITUS BY MANDIBULAR REPOSITIONING

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IN AN ARTICLE written some time ago on mandibular repositioning in obstructive deafness and tinnitus, I [1] advanced the theory that the genetic relationship of the musculature of the mandible, the auditory tube, and the middle ear may be a causative factor. In that article I stated that in the embryo the oral cavity is not distinctly separated from the pharynx, Eustachian tube, and middle ear. The nasopharynx and the nasal cavity become distinct when the palate is formed. The middle ear, Eustachian tube, pharynx, and mouth are lined with mucous membrane. This fact is directly related to the developmental relations of the parts, since the middle ear may be considered a partially separated portion of the pharynx and mouth. In the embryo is also found the pterygoid mass, which splits as the embryo develops. It finally becomes three distinct muscles. The main bulk of the pterygoid mass becomes the largest of the three, namely, the internal pterygoid muscle, the function of which is to protrude the mandible and give it lateral motion. The second muscle is the smaller and less potent tensor palati. Its functions are to tense the soft palate and to open the Eustachian tube. The smallest and least potent of the three muscles from the pterygoid mass is the tensor tympani. This penniform muscle, 2 cm. long, is attached to the manubrium of the malleus, which lies against the tympanic membrane. Its function is to tense this membrane. These three muscles interdigitate. The fibers of the internal pterygoid muscle blend with those of the tensor palati, and the fibers of the tensor palati blend with those of the tensor tympani.

Further evidence of the close interrelationship of these muscles is manifest in their nerve supply. The internal pterygoid muscle is supplied by the large internal pterygoid nerve, a branch of the mandibular division of the trigeminal. The nerve supply to the tensor palati and the tensor tympani consists of small fibers given off from the internal pterygoid nerve. The neuromuscular relationship is a perfect synchronization for the carrying out of muscular function; three muscles with the same embryological origin and the same nerve supply each have a different function.

Living muscles are never inactive but are always in a state of partial contraction or, to put it another way, partial relaxation. This state is called the tone of a muscle. In the action of any muscle numerous other muscles are at work; their action, though secondary, is designed to help the principal movement. Muscles work in groups. Thus one group of muscles opens the mouth, and another group closes the mouth. The larger the muscle the greater its stability and strength and the greater its domination over the muscles with which it functions.

1. Ronkin, S. H.: Repositioning Mandible in Cases of Obstructive (Low Tone) Deafness and Tinnitus, A. M. A. Arch. Otolaryng. **54**:632, 1951.

In view of these facts, it would seem evident that any deviation from the norm of the internal pterygoid muscle, the largest of the three, would immediately cause a deviation from the norm of both the tensor palati and the tensor tympani. Such deviation can take place at the completion of growth, at about the 25th year of life. After growth is completed, changes continue to take place. The process is not perceptible in the beginning but speeds up as senescence approaches. In the mouth a wearing down of the molars begins, that is, a loss of vertical dimension. The loss of tone of the internal pterygoid muscle seems to run concurrently with this wearing down and with both tinnitus and loss of hearing. When there is a change in tone of the internal pterygoid muscle, there is a change in tone of the tensor palati. Thus there is an interference with the opening of the Eustachian tube. This interferes with aeration of the middle ear and can be a decided factor in tinnitus and deafness.

When there is change in tone of the tensor palati, there is a change in tone of the tensor tympani and there immediately follows a change in auditory acuity. The diagnosis, of course, must be made by the otologist. If the internal pterygoid muscle could be restored to its normal anatomical position, I believe that the tensor palati and tensor tympani would resume their normal positions. However, the problem is how to reposition the jaw so that the internal pterygoid muscle may resume its normal position and how to know when its position is normal. The routine prosthetic method of opening the bite by means of measurements is at best unable to meet this problem. In the final analysis one is trying to restore the delicate fibers of the tensor tympani to their normal tone.

In ascertaining the efficacy of any treatment, scientific control of the results is essential.

The otological data in this report come from the files of the New York Eye and Ear Infirmary. All the audiological studies were conducted in the same sound-proof and damp-proof room at this institution. The otological staff was exceedingly cautious of proof of hearing improvement.

We realized that audiograms taken over a length of time in any case of deafness without therapy may show a relatively wide fluctuation of hearing. We also realized that audiograms taken months apart and showing slight improvement would not be acceptable by the critical otologist as proof of hearing improvement. Repeated audiograms were made before treatment began; that is, once a week for two, three, and even four months.

Audiograms were taken during dental treatment, i. e. during the wearing of acrylic blocks and acrylic splints, and once a month after adoption of the final prosthesis.

Although this investigation has been under way for only two years, the following statistical report is presented with the full realization that the "five-year cure" has become more or less the standard for a satisfactory end-result.

It is the purpose of this report to present a study of 93 patients treated by means of dental appliances. Of these patients, 45 were men and 48 were women.

Of the men, 19 were edentulous and were wearing full upper and full lower dentures; 16 had some teeth missing and were wearing partial prosthetic appliances; 4 were edentulous and were not wearing any prosthetic appliance; 4 had some teeth missing and were not wearing any prosthetic appliance; 2 had a full complement of their own teeth.

Of the women, 21 were edentulous and were wearing full upper and full lower dentures; 11 had some teeth missing and were wearing partial prosthetic appliances; 1 was edentulous and had no prosthetic appliance; 14 had some teeth missing but were not wearing any dental appliance; 1 had a full complement of her own teeth.

In all these patients, including the three who had a full complement of their own teeth, the vertical dimension, i. e. the relationship between the maxilla and the mandible, indicated a posterior collapse of the musculature.

TECHNIQUE

The patient was placed in a sound-proof, damp-proof room and a hearing test was given with the audiometer. Then the patient was given a hearing test with a speech-testing machine—a variation of the audiometer—only the tones that come within the normal speaking range being used. The amount of hearing loss and the amount of tinnitus were ascertained in decibels.

TABLE 1.—*Patients with Tinnitus*

Age	No.	Improved 0-5 Db.	Improved 5-10 Db.	Improved 10 Db. or More	Improvement Outstanding	Did Not Continue Treatment
		Men				
21-35	3	..	..	..	..	3
35-50	5	..	1	1	2	1
50-aged	25	3	8	1	..	13
		Women				
21-35	7	1	..	..	1	5
35-50	10	2	..	1	..	7
50-aged	18	3	3	2	..	10
Total	68	9	12	5	3	39

We began to reposition the mandible by using small blocks of acrylic shaped to conform to the mouth. These blocks were placed between the teeth in the molar region. They were made in heights ranging from 1 to 10 mm. By use of these graded blocks we could reposition the mandible 1 mm. at a time. Each time the mandible was repositioned, an audiometric test was made. Once the proper opening was ascertained—and here we were guided by our audiometric readings, which had to show a decrease in decibels—we constructed our acrylic splint at this opening. The splint was not a cemented splint but one that could be removed by the patient. It was worn by the patient at all times except during mastication.

The same procedure was carried out with the splint in position as was carried out with the block in position; that is, audiometric tests were given once a week. When a 10-db. improvement was reached with the splint in position and when this improvement was maintained or bettered over a period of three months, we constructed a permanent prosthesis.

RESULTS

The accompanying tables represent the clinical results obtained thus far.

One of the outstanding cases of Table 1 was that of a man 35 years of age who had a full complement of his own teeth. His teeth, in fact, were free from

fillings. From the dental viewpoint it might be said that he had a nearly perfect dentition. I say "nearly perfect" because the cusps of the molar teeth did show some wear. His tinnitus was of the tone type, the noise sounding like a low buzz at 512. He stated that this buzz had started about four months previous to

TABLE 2.—*Patients with Hearing Loss*

Age	No.	Improved 0-5 Db.	Improved 5-10 Db.	Improved 10 Db. or More	Improvement Outstanding	Did Not Continue Treatment
		Men				
21-35	2	..	..	..	..	2
35-50	5	2	1	1	..	1
50-aged	25	..	10	2	..	13
		Women				
21-35	8	2	2	1	..	3
35-50	12	3	..	2	..	7
50-aged	19	5	1	1	..	12
Total	71	12	14	7	..	38

TABLE 3.—*Patients with Combined Tinnitus and Hearing Loss*

Age	No.	Improved 0-5 Db.	Improved 5-10 Db.	Improved 10 Db. or More	Improvement Outstanding	Did Not Continue Treatment
		Men				
21-35	2	..	..	..	..	2
35-50	5	1	1	..	2	1
50-aged	25	3	7	1	1	13
		Women				
21-35	6	1	1	1	..	3
35-50	10	..	2	1	..	7
50-aged	14	3	1	1	..	9
Total	62	8	12	4	3	35

TABLE 4.—*All Patients*

Age	No.	Improved 0-5 Db.	Improved 5-10 Db.	Improved 10 Db. or More	Improvement Outstanding	Did Not Continue Treatment
		Men				
21-35	3	..	..	..	..	3
35-50	5	1	1	..	2	1
50-aged	37	2	8	2	1	19
		Women				
21-35	9	2	2	..	1	3
35-50	12	1	2	2	..	5
50-aged	27	5	2	3	..	17
Total	93	11	15	7	4	48

our seeing him. On Aug. 29, 1951, his tinnitus measured: air conduction, right ear, 512 cps at 65 db.; air conduction, left ear, 512 cps at 70 db.

A 1-mm. splint was placed in his mouth and he was instructed to wear it as much as possible. He reported to us the following week that after he wore the splint for a few hours the noise greatly increased and then disappeared. After he had worn the splint for three months, during which time he was completely free

of tinnitus, the splint was broken and a new one had to be made. This took 10 days, during which the tinnitus returned but was not as severe as before. One year later there had been no recurrence of the tinnitus. In view of the fact that this patient had a full complement of his own teeth and that his splint was at best only a temporary appliance, we will endeavor to construct a removable overlay which he will be able to use as a permanent prosthetic appliance.

Another outstanding patient of Table 1, representing tinnitus, was a white married woman aged 29, who had been deaf since she was 16. Her tinnitus, of the tone type and of 12 years' duration, was a steady pounding with occasional bell sounds in both ears.

The first open-field test was done on March 30, 1951, and showed a 67-db. hearing loss. The usual acrylic blocks were made and worn by the patient for one month. Then an acrylic splint was constructed. Our audiometric readings guided us to a 4-mm. opening. The patient's mandibular 6-year molars and 12-year molars on both sides had been extracted many years before, and there was a definite posterior collapse of the musculature. On Oct. 17, or approximately seven months later, the open-field reading was 36 db., a gain of 31 db. in hearing acuity. The tinnitus was completely gone. At this point the splint was taken away from the patient to ascertain whether she would be able to retain the gains that she had made with the splint in position. For one month we took weekly audiometric readings. The decibel loss began to climb and the tinnitus reappeared, but neither the hearing loss nor the tinnitus was as intense as when we first saw her.

The splint was returned, and finally it was replaced with a permanent prosthesis. The tinnitus completely disappeared, and the hearing loss decreased to 34 db.

Regarding the total of 48 patients listed under the "Did Not Continue Treatment" column in Table 4, I should like to mention that many of these patients were wearing splints and showed an increase in hearing acuity up to 10 db. However, since their treatment did not continue beyond a three-month period, they have not been included in the results.

In conclusion, I believe it worthy of consideration that in those cases in which the results have not been clinically spectacular, we have at least been able to decrease the decibel loss, and in no case was there an increase of hearing loss.

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"SILENT" CHOLESTEATOMA

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THE PURPOSE of this article is to call attention to the problem of "silent" cholesteatoma. It is not our intention to discuss the various theories of the formation of otogenic cholesteatoma; however, we do feel that none of the existing theories satisfactorily explains all cases. The one common finding in our group of cases was that at various stages or throughout the course of the otologic disease no perforation of the drum or attic was present. Complicating symptoms, such as labyrinthic fistula, can lead to a misdiagnosis of Ménière's disease; facial paralysis resembles Bell's palsy, and conductive deafness can be ascribed to otosclerosis, as in two recent cases of fenestration. Recent experiences with a large group of cases have made us alert to the existence of "silent" cholesteatoma as a causative factor in otherwise obscure otologic symptoms. The following cases were selected to illustrate this problem.

REPORT OF CASES

CASE 1.—G. K., a woman aged 21, on Sept. 13, 1950, gave a history of recent upper respiratory infection associated with pain in the right ear and face and a discharge from the right ear of several days' duration. In the past few months she had had three episodes of right otitis, diagnosed as external otitis, which had always healed with penicillin. In infancy she had had several attacks of otitis media, one of which was associated with scarlet fever. After these early episodes there had been no intervening ear difficulty.

Examination showed a pinpoint perforation in the attic with an intact pars tensa and normal hearing. The ear responded to one dusting with aureomycin powder, and no perforation of the attic was visible on healing. X-rays of the mastoid showed some disturbance of pneumatization but no bone destruction. The Mayer view did not reveal any erosion of the lateral attic wall. There were several recurrences of these episodes, and on Nov. 15 mastoid pain and dizziness with 1 degree nystagmus to the opposite side developed. The patient was hospitalized and penicillin administered. On the following day there was a spontaneous discharge; cultures showed Staphylococcus albus, coagulase negative and penicillin sensitive. On Nov. 17 an atticomastoidectomy was performed, with an endaural flap as used in fenestration. The cell structure of the mastoid was normal though small. On exposure of the attic, the ossicles were found to be normal, and no granulations were seen. On dissection forward, anterior to the head of the malleus, a 5-mm. cholesteatomatous sac which spread medially toward the dome of the vestibule was found. Under magnification this was removed from its attachment to the pars flaccida of the drum. Recovery was uneventful except for about six weeks of dizziness on sudden motion. The hearing remained normal postoperatively.

Read before the Chicago Laryngological and Otological Society, Jan. 5, 1952.

From the Illinois Eye and Ear Infirmary, The University of Illinois College of Medicine.

This patient was thought to have external otitis because penicillin given parenterally or local treatment resulted in complete healing and the obscure pinpoint perforation of the anterior epitympanic recess was overlooked during the infections. Mastoid surgery was delayed, because of the absence of findings on x-ray examination and the rapid resolution of individual attacks with local treatment, until symptoms of labyrinth irritation intervened.

CASE 2.—Dr. J. K., aged 38, gave a history of scarlet fever with otitis media at age 7. There was no ear disease afterward until an attack of acute otitis media in 1936; this healed with local treatment. During preinduction examinations in 1939 and 1940 the ear was studied by several otologists, including one of us, and no perforation was found. In 1941, while the patient was in the army, acute otitis media with an attic perforation developed during an upper respiratory infection. A granuloma projecting from the perforation was cauterized repeatedly, with no improvement. He was allowed to go home on leave with permission to consult one of us (R. H.). The granuloma was removed and the base cauterized. A few days later a projecting mass of cholesteatoma was seen, and an attic irrigation was performed. A large amount of cholesteatoma was removed, and removal was followed by an episode of dizziness and 3-degree nystagmus which lasted 24 hours. No elevation of temperature occurred. When this episode subsided the epitympanum remained dry, but a large defect in the lateral attic wall persisted. The hearing showed a 25-db. loss at this time.

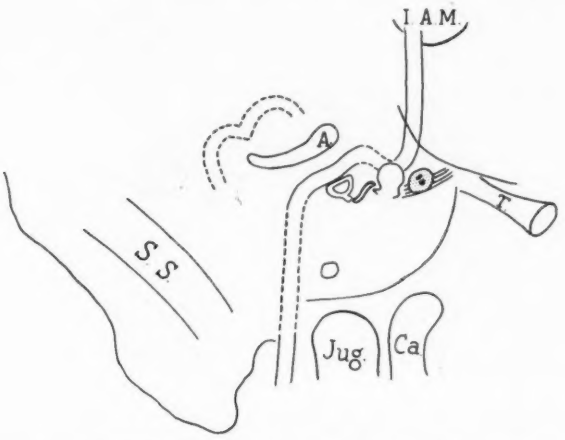

Fig. 1.—Diagrammatic sketch showing small cholesteatoma (dotted area) located anteriorly to head of hammer head. *I. A. M.*, internal auditory meatus; *A*, ampulla of horizontal canal; *S. S.*, sigmoid sinus; *T.*, auditory tube; *Jug.*, jugular bulb; *Ca.*, carotid artery.

The patient was seen at yearly intervals from 1946 until 1951. Throughout this time the ear remained dry, but the hearing regressed from the previous level to 51.9 db., with considerable high-tone loss, although the Weber test was lateralized to the diseased ear and the Rinne test was negative. In 1950, after an upper respiratory infection, dizziness, spontaneous nystagmus of 1 degree, and low-grade fever developed. The attic perforation was filled with a large brown moist mass. The patient was hospitalized, given 300,000 units of penicillin daily, and kept at bed rest for one week. On Aug. 1 an atticomastoidectomy with an endaural flap as used in fenestration was performed. At operation a large cholesteatoma which had eroded the entire mastoid process was found. After all the diseased tissue had been removed, it was possible to remove a V-shaped portion of the flap, including the perforation, to seal off the middle ear. The ear has remained dry and hearing loss is 42 db.

In this case the cholesteatoma was not recognized, in spite of repeated observations over many years, until the granuloma which occurred with an acute exacerbation was removed. The fact that on three separate occasions an acute otitis media occurred with the attic as the site of perforation should have led to a search for a cholesteatoma, but in the intervals between attacks the drum and attic were intact and normal. This case in its later course also demonstrates that in spite of a dry perforation cholesteatoma in the mastoid may progress unsuspected until some complication supervenes.

Case 3.—F. G., a man aged 47, had progressive hearing loss in the left ear, first noticed nine years earlier. Throughout this period there were episodes of severe dizziness, which were relieved by inflations. He gave a history of childhood otitis but no intervening ear disease. Seven weeks prior to admission to the hospital (Sept. 18, 1951) an acute otitis media, spontaneous nystagmus, and dizziness developed. The generalized symptoms and dizziness were controlled by penicillin, but the discharge persisted. The referring otologist stated that prior to this episode no perforation was visible in the attic. Examination of the left ear revealed

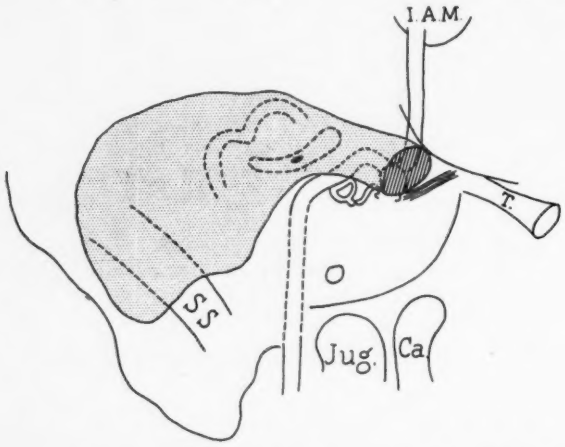

Fig. 2.—Diagrammatic illustration of extensive cholesteatoma in case of dry-attic perforation.

a profuse purulent discharge from an attic perforation. There was complete absence of hearing and the Weber test was lateralized to the opposite side. The uninvolved right ear showed moderate deafness, nerve type. The fistula test was positive. On pressure of the lateral attic wall with an applicator, no bony resistance was encountered, and the patient became dizzy. While the skin in this area was normal, apparently no bony wall was present. X-ray examination showed a sclerotic mastoid with erosion of the lateral attic wall and a large portion of the mastoid process.

An endaural radical mastoidotympanectomy was performed. A large cholesteatoma occupied the entire attic, antrum, and part of the mastoid. On removal of the cholesteatoma, the horizontal canal had a fistula over the ampullated end about 1 by 3 mm., duplicating a fenestration. Under the microscope the membranous canal was seen to be normal and the endosteal membrane seemed a dark grey in contrast to the normal pale yellowish-pink color. The edges were freshened. The facial canal was found eroded in its horizontal position. No ossicles were seen. The cholesteatomatous mass had continued into the middle ear and eroded part of the promontory and the round-window niche. When all diseased bone was removed, a graft was inserted into the mastoid cavity with particular care to cover the fenestra and the facial nerve. The cavity healed within one month, but the patient coninued to experience serious episodes of dizziness. The fistula test was strongly positive.

Because of incapacitating dizziness and absence of hearing, a destructive labyrinthotomy was performed Nov. 24, 1952, with the patient under general anesthesia. The endaural incisions were reopened and the flap elevated. The previous fistula was found partially closed. The anterior portion remained patent. No evidence of cholesteatoma was found. The fistula was reopened to a complete exposure of the ampullated portion of the canal, and the fibrous mass attached to the membranous canal was removed with as much of the utricle as could be obtained. Fluid was aspirated from the empty vestibule and the dry field examined under the microscope. Apparently about every 45 sec. the labyrinth refilled with fluid. This was aspirated and the process repeated several times. While no conclusions can be drawn from this pathological case, one must reexamine Lempert's statement that perilymph is not under positive pressure. Perhaps both observations are true, and in this particular instance a postive pressure much greater than that observed in fenestration for otosclerosis, and possibly related to the dynamics of the vertigo, was observed. The fluid was touched with coagulating diathermy current. With each momentary application of the current, lateral deviation of the head occurred to the same side. The vestibule was packed with bone chips and the flap replaced.

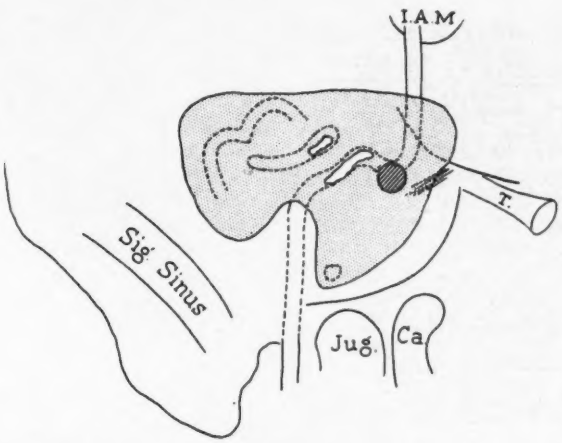

Fig. 3.—Sketch of large cholesteatoma in middle ear and mastoid process with no perforation in drum and erosion of horizontal and facial canals.

Postoperatively the spontaneous nystagmus subsided within 48 hours, and there has been no further dizziness.

This patient had no perforation of the drum or attic for over 10 years, with a progressive hearing loss and vertigo. The vertigo was relieved by inflations, and no x-rays were taken. When spontaneous rupture of the lateral wall occurred and the associated otitis did not heal with antibiotics, the underlying cholesteatoma was discovered.

Case 4.—E. L., a Negro woman aged 36, came to the infirmary on Oct. 31, 1952, complaining of loss of hearing in the left ear of five years' duration. She stated that she had earaches as a child but no discharge from the ear. One and a half years earlier she had noticed a weakness of the left side of the face. Within two weeks a complete facial paralysis occurred. Her physician diagnosed Bell's palsy and treated her with diathermy.

On examination the left drum membrane was intact. Shrapnell's membrane was retracted, but no perforation was seen. The hearing test revealed a conduction-type of deafness with lateralization to the affected ear and a negative Rinne test on that side. Bone conduction was

bilaterally equal and within normal limits. Whisper voice was heard at a distance of 2 ft. (61 cm.) and conversation voice at 5 ft. (152 cm.). There was a complete facial paralysis on the left side. Rotation tests were shortened in duration to about 12 to 14 sec. bilaterally. Caloric stimulation of the left labyrinth was absent with maximal cold stimulation. Roentgen films of the temporal bones in the usual positions showed on the left side a large defect of the mastoid extending medially to the internal canal in the Towne view. There was involvement of the semicircular canals in this area. The roentgenologist believed that these findings

Fig. 4.—Photomicrograph of bony section removed from labyrinthic fistula, showing new bone formation under layer of fibrous connective tissue. Attached ampullar end of membranous canal is partly filled with young connective tissue and infiltrated with lymphocytes.

were suggestive of destruction by a tumor. The results of electrical testing of the facial muscles were consistent with a state of partial innervation.

In view of these findings, surgery of the temporal bone was performed. With the patient under general anesthesia, a postauricular incision was made. The lateral attic wall was destroyed, and a large cholesteatoma was found to have eroded the head of the malleus, the facial nerve canal, the promontory wall, and the labyrinth medially as far as the internal auditory canal. The tegmen over the antrum and medially over the arcuate eminence was gone. The cholesteatoma extended inferiorly, exposing the carotid artery and the jugular bulb.

In spite of loss of hearing and facial nerve paralysis, no otologic involvement was suspected. When routine x-ray examination was performed, destruction of the mastoid as a cause of these symptoms was revealed. The only finding that suggested cholesteatoma was the retracted Shrapnell membrane.

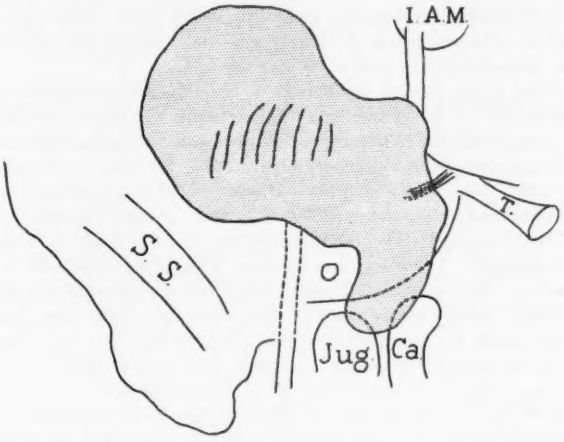

Fig. 5.—Diagram showing extensive cholesteatoma eroding labyrinth, facial nerve, and bony walls of jugular bulb and of carotid artery. Drum showed only retraction of pars flaccida.

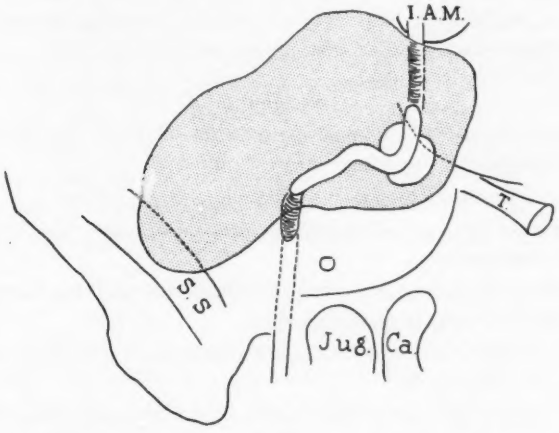

Fig. 6.—Diagrammatic sketch of massive cholesteatoma in case of transient attacks of acute otitis and long-standing facial paralysis.

Case 5.—G. C., a man aged 45, gave a history of discharge from the right ear of two weeks' duration in 1945, following swimming. In 1950 he had pain in the right ear which lasted two days and subsided with local treatment. With the onset of pain, he noticed weakness of the right facial muscles. For four months prior to admission, the facial paralysis was complete except for ability to close the eye. He was conscious of a "corkscrew-like" pressure in the right ear but there was no pain, vertigo, nausea, or discharge.

On admisison, July 18, 1952, the right ear canal showed an attic perforation covered by dried bloody crust and no discharge. The Weber test was lateralized to the affected ear; the Rinne test was negative. The patient was unable to hear whispered voice but could hear conversational voice at 5 ft. The crust was removed by the resident physician, and a few days later, when the patient was observed by the staff, no perforation was visible but retraction of Shrapnell's membrane was present. Electrical facial-nerve testing indicated facial-nerve paralysis with partial involvement of the orbicularis oculi. X-ray examination showed a large mastoid destruction including the lateral attic wall, tegmen mastoid process, and bony labyrinth to the internal auditory meatus.

With the patient under general anesthesia, an endaural mastoidotympanectomy was performed. On opening of the mastoid, a large cholesteatoma was found exposnig about 1.5 cm. of the sigmoid sinus, and the entire tegmen of the middle fossa in relationship to the ear was absent. This anteroposterior defect measured 3.5 cm. Medially, it extended 3 cm. beyond the horizontal canal. There was a blood cyst present on the dural surface, and on retraction of this area a small tear in the dura occurred, so that for the remainder of the operation spinal-fluid leakage continued. The facial nerve was lying free in its middle-ear portion, covered with granulations. There was a bony-canal sequestrum in the area of the geniculate ganglion. When the cholesteatoma, the granulation, and the sequestrum were removed, the facial nerve was seen to be swollen to about three times its normal size. The cholesteatoma involving the area about the facial nerve to the internal auditory meatus was then removed. The entire cavity was packed with oxidized cellulose after a graft was inserted into the mastoid. Recovery was uneventful except that, while electrically there was evidence of facial-nerve improvement, no clinical improvement could be seen until four months postoperatively. The facial nerve paresis has continued to improve slowly. At ten months after operation he had about 80% function.

This patient had transient episodes of acute otitis media. Facial paralysis was present for two years prior to admission. The drum had a transient perforation, which healed spontaneously. This history and the roentgenograms of the temporal bone led to a diagnosis of cholesteatoma, previously unsuspected.

CONCLUSIONS

These cases illustrate "silent," unsuspected cholesteatoma. From our experience, we feel that the following conclusions are warranted.

1. Repeated attic discharges may simulate an external otitis.

2. The presence of a normal-appearing drum membrane does not exclude the existence of cholesteatoma.

3. Loss of hearing, facial-nerve paralysis, conduction deafness, vertigo, and headache may be the first signs of cholesteatoma.

4. Attic perforation in acute middle-ear infections is associated with cholesteatoma, no matter how minute.

5. Careful history and x-ray examination of the temporal bone often reveal an otherwise unsuspected cholesteatoma.

6. Cholesteatoma in cases of intact-appearing drum membranes or small perforations should always be treated surgically.

7. Whenever an atticomastoidectomy with an endural flap is performed, as in a Bondy operation, all the matrix should be removed meticulously; otherwise the flap may seal off the remnants and cause a re-formation of cholesteatoma. The matrix should also be removed completely in a mastoidotympanectomy in order better to skeletonize the underlying bone pathology.

Case Reports

SHEET OF TANTALUM TO REPLACE ALAE OF THYROID CARTILAGE

Use in Maintaining Patency of Larynx after Partial Laryngectomy

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ATHENS, GREECE

SELECTION of the kind of operation for cancer of the larynx depends on the localization and the extent of the tumor. Among the various kinds of operation are cordectomy, total laryngectomy, and partial laryngectomy of different types, the object of which, besides the radical removal of the growth, is to maintain the normal relations and functions of the larynx. In most of these cases, despite the removal of a more or less large portion of one or both of the alae of the thyroid cartilage, after complete healing the laryngeal lumen is wide enough for the tracheostomy tube to be dispensed with permanently. But in some cases apposition of the soft tissues and development of scar tissue result in stenosis of the larynx, i. e., the healed air space of the glottis is insufficient, and the permanent wearing of a tracheostomy tube is necessary.

In these particular cases I think it advisable to replace the removed portion of the alae of the thyroid cartilage with a sheet of tantalum of a determined thickness. Tantalum, though hard, can be cut, given any shape necessary to form the angle of the thyroid cartilage, and sewed on the remaining part of the alae with metal wire.

As I have not come across a similar method in the accessible literature, I thought it advisable to publish the following case, in the hope that it might prove of some use to laryngeal surgeons who may wish to apply it in similar instances.

REPORT OF CASE

A man aged 49 presented himself on June 17, 1952, complaining of hoarseness which had persisted for five months. He was a heavy smoker. The examination revealed extensive growth involving the anterior part of the right cord, the anterior commissure, and the whole ventricle on the left side. The motion of both sides was unimpaired. No lymph nodes were palpable on the neck.

Biopsy showed epidermoid carcinoma. I operated on him on June 23, 1952. Under local anesthesia, the usual incision was made through the skin and subcutaneous tissues. Blunt subperichondrial dissection outside and inside the thyroid cartilage was done in such a way that a part on the right side and almost the whole of the alae on the left side were exposed and removed with scissors. Because of the extent of the growth I performed the excision, with an electric knife, of nearly the entire left half of the larynx encompassing a large part of the opposite cord. Then, seeing that the apposition of the soft tissues would be unavoidable and maintenance of

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the lumen of the larynx impossible, I took a sheet of tantalum, cut it, gave it the shape of the removed portion of the alae, and sewed it on the remaining parts of the cartilage with metal wire. This sheet of tantalum is clearly seen in the roentgenogram.

Sheet of tantalum substituted for the removed portion of the alae of the thyroid cartilage.

A tracheostomy tube was left in the upper part of the trachea. Closure of the wound was in two layers. Injections of penicillin were given. The tube was removed after several days.

Six months after the operation, the patient was well; he breathed normally, and his voice was very satisfactory.

Roosevelt St. 31.

Clinical Notes, New Instruments and Techniques

USE OF POLYETHYLENE TUBING IN NASAL SINUS SURGERY

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PASADENA, CALIF.

A method of maintaining a patent nasofrontal duct by the use of polyethylene tubing is presented. This technique is of value for patients with mucoceles of the frontal sinus and may be of aid for persons with chronic frontal sinusitis, provided surgery as advocated by Boyden [1] has first been used. Also presented in this report is a modification in handling a nasoantrostomy by using a similar procedure.

Various materials have been advocated, tried, and found wanting for maintaining a patent nasofrontal duct. These have included skin [2] and mucous membrane,[3] rubber,[4] acrylic substances,[5] gold,[6] and tantalum.[7] Factors which have limited the use of these substances have been availability, irritation, malleability, and cost. A chemical substance which has none of the various objectionable features of previously tested materials has been found in polyethylene (polythene).

The first reports of this new substance were presented by Ingraham, Alexander, and Matson [8] and by Brown, Grindlay, and Craig,[9] in 1947. They presented their findings on the use of polyethylene in brain surgery.

Polyethylene is completely insoluble in all known solvents at temperatures up to 60 C., and does not melt in boiling water. Polyethylene is flexible, tough, light in weight (specific gravity 0.92), an excellent insulator, and transparent to x-rays. It holds sutures well. Its other virtues are that it is inexpensive and that it is easily sterilized by chemicals or boiling water. It can be cut easily with knife or scissors; when heated in boiling water it can be readily molded, and upon cooling it retains its molded shape.

In the original and subsequent reports there has been no mention of foreign body or inflammatory reaction (other than a fibrous tissue response adjacent to the tube) regardless of its

From the Department of Otolaryngology, The University of Southern California School of Medicine, Los Angeles.

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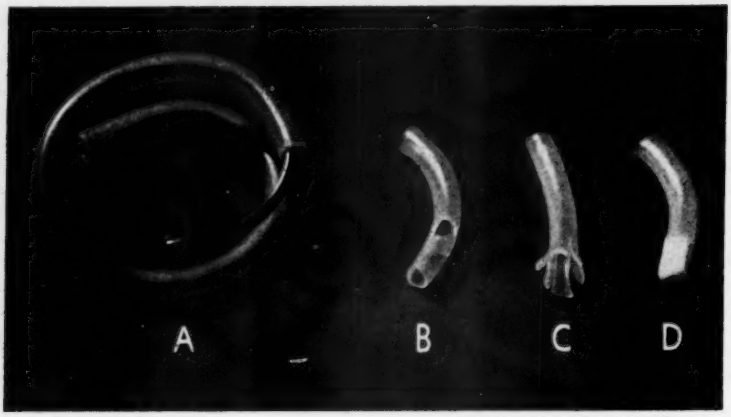
use, whether in neurosurgery,[10] general surgery,[11] anesthesia,[12] or gynecology.[13] The problem of permanent blocking of a nasofrontal duct in an acute frontal sinus infection is practically negligible, provided the duct is not damaged by surgery,[14] done according to the technique as outlined by Brown.[15]

Chronic frontal sinus infection with damage to the nasofrontal duct is potentially a condition necessitating the formation of a permanent nasofrontal duct. The need to maintain patency of the duct is most evident in the presence of a mucocele.

The initial step in the technique advocated to produce a permanent nasofrontal duct is to make a Lynch incision, opening the frontal sinus, drain the sinus, and then form an opening into the nose sufficiently large to take a polyethylene tube [16] of 5.95, 6.86, or 7.35 mm. in diameter. The tubing, being flexible and readily molded by boiling, is placed on a curved Kelly forceps, boiled and cooled on the forceps, thus giving a slight curve. The end of the tubing in the frontal sinus is enlarged by molding over a nasal speculum in boiling water. Should additional flanging of the tube be desired, this may be accomplished by cutting the tubing longitudinally in three to five places. The flanged end may be sutured in place; however, this has not been found necessary. When placed in position, the tubing, approximately *2* cm. long, will extend well into the nostril. There is relatively little after-care required. The tube is left in position permanently.



Polyethylene tubing as used in sinus surgery. *A*, method of maintaining curve in polyethylene tubing by placing on curved wire; *B*, piece of tubing ready to be placed in antrum; *C*, tubing as used by Higbee [17] without capsule; *D*, tubing with capsule on one end, to facilitate insertion into the antrum, as advocated by Higbee.

The procedure using polyethylene suggested in the care of a nasoantrostomy is as follows: At the conclusion of a routine nasoantrostomy, a piece of polyethylene tubing is placed on an

10. Ingraham, Alexander, and Matson.[8] Brown, Grindlay, and Craig.[9]

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15. Brown, J. M.: Frontal Sinusitis, Tr. Am. Laryng. Rhin. & Otol. Soc. **50**:314-317, 1946.

16. Polyethylene is available through surgical supply houses in sheets or tubing of all sizes; distributed through Clay Adams Company, Inc. 141 E. 25th St., New York 1.

antrum trocar and slipped through the nasoantrostomy opening. When the trocar is removed, the tubing is left in situ. The polyethylene tubing used is 4 cm. long (of 5.95 or 6.86 mm. diameter) molded to a gentle curve by placing on a Kelly curved forceps or coil of wire, preferably galvanized 12-gauge wire rolled into several complete curves of 6 cm. diameter. The wire is run through the polyethylene tubing and boiled, and a piece of tubing the proper length is cut off as needed. Several holes are cut through the side wall of the tubing in that portion left within the antrum. The tubing is left in place six to eight weeks, or as long as desired. The antrum may be irrigated several times during this period, if desired, by means of a Coakley irrigator. The tubing slips out of the antrum easily without the use of an anesthetic when its removal is desired. A modification of this procedure has been recommended by Higbee.[17] He uses the tubing as recommended, and, in addition, he flanges the end within the sinus by slitting the tubing five or six times, and holds the flanged end together prior to its inserting into the antrum by putting it into a gelatin capsule. The capsule melts promptly.

The advantage in using the polyethylene tubing in the nasoantrostomy opening is that it maintains a large opening as long as the tube is left in place. There is no need for frequent irrigation of the antrum or for use of other local treatment unless desired by the physician. During the period of treatment, the patient is seen occasionally, on an average of once every two weeks. The patients on whom we have used this procedure during the last year or so have responded more favorably than those treated by previous methods.

REPORT OF CASES

A 35-year-old man, was first seen in February, 1948. He had proptosis of each eye and a firm swelling of each frontal sinus. He wore heavy glasses of 18 Δ in each lens, in the vertical plane. He gave a history of having had bilateral frontal sinus surgery in 1931-1932. X-rays taken revealed no tumor mass; there was an absence of the left orbital roof. The right and left frontal sinuses were aspirated, and 10 cc. of thick yellow mucoid discharge was obtained from each sinus. The patient stated at that time that he would rather come back for an occasional aspiration than have surgery. A bilateral frontal sinus aspiration was done again in June 1949. Another aspiration was attempted in December, 1949, and 2 cc. of thick black secretion, resembling heavy motor oil, was obtained, with no relief, and then the patient consented to surgery. The right and left frontal sinuses were opened, and a curved polyethylene tube, 6.86 mm. in diameter and 2 cm. long, was placed at the sites of the right and the left nasofrontal duct. Subsequent to surgery, the patient's eyes straightened; he does not wear glasses now, and there is only slight proptosis of the eyes. There has been no return of frontal sinus involvement. Since surgery, the patient has had one upper respiratory infection (January, 1952), which responded promptly to treatment. There has been no reaction to the polyethylene tubing to date; it has not become blocked, and the tubes are permanently located in the nose.

An 8-year-old girl with a history of extensive allergies and under the care of an allergist, was referred by the allergist to find a focus of infection for the allergy. X-rays taken revealed opacity of the right and left antra. Bilateral antral irrigation yielded 6 cc. of thick mucoid yellow discharge from each antrum. Two weeks later an acute respiratory infection developed and the child's temperature reached 103 F. She was admitted to the hospital, where with the patient under general anesthesia bilateral nasoantrostomies were done and a polyethylene tubing was placed in each antrum. The postoperative course proceeded normally. The tubes were removed five weeks later; the patient was seen three times during this period. When last seen the patient had no complaint, and the nasoantrostomies were patent.

SUMMARY

The use of polyethylene tubing as a permanent implant for mucoceles of the frontal sinus and in surgery for chronic frontal sinusitis is presented. Its use as an adjunct in nasoantrostomy surgery is discussed.

Polyethylene tubing, in providing an inert substance for use in sinus surgery, has been found to decrease markedly the postoperative care of patients with sinusitis for whom its use is indicated.

17. Higbee, D.: Personal communication to the author.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology for 1951

TONSILS AND ADENOIDS

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INDICATIONS

CONSIDERATION of tonsils and adenoid tissue has been directed principally in the past toward when they should be removed. Recently, however, physicians have come to realize that there are definite times and circumstances during which adenotonsillectomy is better deferred, or is even contraindicated. In addition, some have begun to attribute definite beneficial functions to these structures.

Hoover [1] believes that when the removal of pharyngeal lymphoid tissue would not be of benefit to the patient, i. e., when existing disease will not be cleared up or when the recurrence of previous difficulties will not be prevented, then the removal is contraindicated. Especially is this true when surgical intervention might further complicate a patient's condition, as in the presence of hemophilia, leukemia, acute anemia, Hodgkin's disease, or carcinoma, or during an acute infectious disease or upper respiratory tract infection. He does not consider age as a contraindication, stating that when definite indications exist an operative procedure should be carried out.

Lederer [2] reminds his readers of how far the pendulum of medical opinion regarding tonsils and adenoid tissue has swung, and states that most of the indications for the removal of these structures have been based on the focus of infection theory, which has been carried to the point of abuse. He points out that now a concerted educational effort is being made "to unfetter the medical world from the surgical ritualistic approach to the removal of tonsils and adenoids." Large size alone is never an indication for the removal of tonsils, and allergy is an often neglected aspect of the consideration. Lederer lists the following contraindications: (1) age of patient less than 3 years (preferable age is 5 or 6 years); (2) presence of an acute local process, fever, and/or albumin in the urine, contagious or infectious diseases, pulmonic disease, vascular anomalies in the tonsillar region (although he does not point out how to determine this), and bleeding states; (3) conditions rendering local or general anesthesia risky, and (4) vague indications that frequently call for a stretch of the imagination.

From the Department of Otolaryngology, Southwestern Medical School of the University of Texas.

1. Hoover, W. B.: Lymphoid Tissue of the Pharynx, S. Clin. North America **31**:911 (June) 1951.

2. Lederer, F. L.: Indications for Tonsillectomy and Adenoidectomy, Postgrad. Med. **10**: 191 (Sept.) 1951.

Lists outlining positive indications for adenotonsillectomy are frequently found. Hoover's list [1] is as follows: (1) hypertrophy to the extent of obstructing respiration, deglutition, or the Eustachian tube; (2) repeated attacks of acute infection or adjacent cellulitis or abscess; (3) evidence of chronic infection associated with symptoms of disease elsewhere, including carriers of pathogenic organisms, such as streptococci or Corynebacterium diphtheriae, and (4) a neoplasm in the lymphoid tissue.

In discussing the pros and cons of tonsillectomy, Gale [3] points out the wide differences of medical opinion and the array of lists of indications and contraindications, stating that these probably account for the wide variation in the percentage of the population tonsillectomized in different parts of England. These percentages vary from 20 to 80% in school children. As an example of indication lists, with which he is not entirely in agreement, Gale presents the following, set forth by Kaiser:[4] (1) interference with normal breathing, snoring, etc.; (2) difficulty in swallowing; (3) nasal or altered voice; (4) persistent nasal discharge; (5) impaired hearing and otitis media; (6) repeated attacks of tonsillitis or quinsy; (7) enlarged cervical glands; (8) sinus trouble; (9) growing pains or rheumatic fever; (10) pyelitis or nephritis; (11) unexplained malnutrition and anorexia, and (12) retarded mental development.

Gale divides the indications generally into two types: those associated with purely local conditions and those associated with general conditions, especially those in which the Streptococcus pyogenes is believed to play a part. On the basis of opinions given at a recent discussion of the Royal Society of Medicine,[5] he lists the indications which seem to be generally accepted by clinicians.

1. Tonsils should very rarely be removed before the age of 5 years. Adenoids should be removed at any age if they are causing nasal or Eustachian tube obstruction. It must be remembered that there are common causes of nasal obstruction other than adenoids.

2. The operation should not be performed on a child who has never had symptoms, whatever may be the appearance of the tonsils. Their appearance varies enormously in the same child at different times.

3. Tonsils should be removed on account of frequent attacks of tonsillitis with fever. True tonsillitis should be distinguished from the transient sore throat which often precedes the development of a cold in the head. The exact number of attacks in a year which should be regarded as significant is disputed—some would say two, some three or four. It is perhaps more important to consider the degree of general disturbance—temperature and duration—rather than the exact number of attacks. In this connection, it is misleading to think only of "sore throats," because a child may have a quite severe degree of general disturbance due to tonsillitis without complaining much of sore throat.

4. Tonsils should be removed at a suitable interval after a quinsy.

5. Tonsils should be removed in the very rare instances when they are so large that they cause mechanical obstruction.

6. Tonsils should be removed in chronic diphtheria carriers when other treatment has failed.

Gale mentions general diseases (juvenile rheumatism and nephritis) and enlarged cervical glands as disputed indications.

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3. Gale, A. H.: Pros and Cons of Tonsillectomy, Brit. M. J. **1**:133 (Jan. 20) 1951.

4. Kaiser, A. D.: The Significance of the Tonsils in the Development of the Child, J. A. M. A. **115**:1151 (Oct. 5) 1940.

5. Discussion on the Tonsil and Adenoid Problem, Proc. Roy. Soc. Med. **43**:317 (May) 1950.

The indications for adenotonsillectomy are divided by Lederer [2] into absolute and relative indications. The absolute indications are (1) frequent attacks of acute tonsillitis, with fever, malaise, dysphagia, etc.; (2) recurrent attacks of peritonsillar abscess; (3) recurrent or persistent cervical adenopathy, and (4) gross hyperplasia of the tonsils and/or adenoids producing a mechanical obstruction to breathing or swallowing and causing an alteration in the speech. The relative indications, which in themselves do not constitute indications at all but when taken in a total sense and in the absence of other findings might be so considered, are (1) repeated sore throats; (2) unexplained fevers; (3) dry tickling or spasmodic cough; (4) chronic otorrhea or repeated attacks of serous otitis media; (5) failure of the child to gain weight; (6) diphtheria carriers; (7) frequent and continuous colds and mucopurulent rhinitis, and (8) pathologic tonsils.

Lederer states that the adenoids have always been suspect when there are such symptoms and signs as nasal obstruction, mouth breathing, snoring, ear trouble, running nose, high-arched palate, dental overcrowding, or malocclusion. Now, however, he states that the indications are narrowed down in most instances to the question of development of a middle ear deafness due to the presence of adenoid tissue in the region of the Eustachian tube orifices. Most writers still agree that adenoidectomy should be performed when the indications for it are present, regardless of the age of the child.

György and Székely [6] simplify the indications for operation by saying that when the tonsils cannot longer fulfill their protective functions, then their removal is indicated.

Another list of indications is given by Leivers,[7] as follows: (1) deafness, of the conduction type, caused by Eustachian tube obstruction, serous otitis media, or acute, chronic, or recurrent purulent otitis media; (2) nasopharyngeal obstruction from an adenoid mass, with mouth breathing, purulent rhinitis, or sinusitis; (3) oropharyngeal obstruction from extreme hypertrophy of the tonsils; (4) recurrent tonsillitis or peritonsillar infections; (5) recurrent cervical adenitis, and (6) diphtheria carriers. He condemns routine adenotonsillectomy, and states that infants with a suspected complete congenital deafness should not be subjected to any throat operation in the absence of definite indications and until a complete study is made of the hearing problem.

FOCUS OF INFECTION

Whether tonsillar infection is chronic or repeated acute, or acts as a focus of infection with distant manifestations, it always appears on every list of indications for removal of pharyngeal lymphoid tissue.

An interesting concept of the role of tonsils in the production of systemic disease is presented by King.[8] He states that years of practice have shown him that certain streptococcic infections, notably tonsillitis, characterize the histories of many cases of "degenerative" cardiovascular diseases (coronary disease and hypertension). He believes that such infections lead to the rheumatic state or "streptococcosis," with

6. György, E., and Székely, Á.: Absorption and Effect of Penicillin Injected into the Tonsils on the Bacterial Flora of the Tonsils, Acta oto-laryng. **39**:62 (Feb.) 1951.

7. Leivers, E.: Adenotonsillectomy: Indications and Application of Surgical Techniques, California Med. **75**:351 (Nov.) 1951.

8. King, J. T.: Infections in Cardiovascular Disease (Peter T. Bohan Lectureship in Medicine), Am. Pract. & Digest Treat. **2**:403 (May) 1951.

more than transient damage to the heart and coronary vessels. Although most persons fail to agree or fail to associate repeated past infections with present cardiovascular disease, he obtains a history of repeated throat infections in patients with coronary disease so often that to him "it seems established beyond reasonable doubt that a 'rheumatic state' follows certain streptococcal infections, joint involvement or no joint involvement, also that such rheumatic state may affect the myocardium, whether joints are inflamed or not." He presents a study of the backgrounds of 200 hypertensive patients, using as a control 600 patients in whom there was no suggestion that a Streptococcus could be implicated. Tonsillectomy had been done in 35% of hypertensives under 50 years of age, while only 17% of the controls had undergone it. At Johns Hopkins Hospital, of 150 patients with rheumatic fever or mitral stenosis, or both, 36% had undergone tonsillectomy. The author considers it significant that tonsillectomy had been advised as frequently for hypertensives as for rheumatic fever patients and states that "it seems to argue forcibly in favor of a close relation of demonstrably infected tonsils with premature hypertension." He concludes:

> So I think the course of events must be somewhat as follows: the streptococcus attacks the upper air passages; if the systemic invasion is of a certain type, then frank rheumatic infection follows. If this occurs, we can easily agree, I think, from the evidence, that coronary disease may result, also a high liability to hypertension."

Richtnér [9] studied 860 hospitalized patients with relatively severe polyarthritis, comprising 283 men and 577 women, in order to determine the possible effects of tonsillectomy on this disease. Of the total, 432 had undergone tonsillectomy. His study revealed no statistically significant difference between the tonsillectomized and the control groups with regard to the sedimentation rate, joints involved, or pathological diagnosis, regardless of the history or the pharyngeal findings. These results compare with previous reports that chronic polyarthritis is probably associated more with metabolic disturbances than with infectious conditions.

In the treatment of acute tonsillitis, Wheatley [10] points out that numerous studies have shown that oral penicillin is as effective as parenterally administered penicillin in obtaining satisfactory blood levels. Thus he believes that a new form of treatment for the domiciliary care of acute follicular tonsillitis is provided, especially in children. He reports his results with acute follicular tonsillitis in 22 patients treated with oral penicillin as compared to a control group of 11 children treated with sulfonamides. For children he used a six-hourly dose of penicillin ranging from 100,000 to 400,000 units (daily total of 400,000 to 1,600,000 units), and for young adults the dosage ranged from 400,000 to 800,000 units every six hours (daily total of 1,600,000 to 3,200,000 units). From the time of institution of treatment, which was within 36 hours after onset of symptoms in all cases, the average time for subsidence was 3.7 days with penicillin as compared to 4.2 days with sulfonamide. The average duration of treatment with penicillin administered orally was 3.1 days, and with sulfonamide, 4.0 days. The advantages of oral penicillin over sulfonamide therapy are cited as virtually no side-effects (one case

9. Richtnér, N. G.: Tonsillectomy in Chronic and Postacute Rheumatoid Arthritis, Acta oto-laryng. **38**:419 (Oct.) 1950.

10. Wheatley, D.: Acute Follicular Tonsillitis Treated with Oral Penicillin, Practitioner **166**:166 (Feb.) 1951.

of mild erythema in his series), lack of necessity for alkali and extra fluids, and avoidance of unpleasant reactions to sulfonamides, such as headaches, nausea, and malaise.

The occurrence of hypoglycemia in two children with acute tonsillitis is reported by Kao, Feng, and Yuan.[11] Factors contributing to the development of this condition in the presence of acute tonsillitis are high fever, anorexia, and vomiting. The increased metabolic rate and infection tend to deplete the carbohydrate reserve; the anorexia and vomiting cause inadequate caloric intake, and the diarrhea reduces the absorption of available carbohydrate from the intestine. Hypoglycemia should be watched for in seriously ill children, since the central nervous system suffers when adequate carbohydrate is not provided. Common symptoms are fatigue, headache, flushing, sweating, and speech, visual, and motor disturbances, such as incoordination, tremors, paralysis, and syncope. Convulsion, irritability, hunger, vomiting, and subnormal temperatures are also seen as symptoms. The proper treatment is replacement of carbohydrate and adequate treatment for the tonsillitis.

A study of 268 patients with chronic tonsillitis was carried out by Christofferson and Richtnér [12] to determine the species and percentages of pathogenic and apathogenic bacteria present in tonsils during a quiescent period when tonsillectomy was performed. Correlation was also attempted between the clinical diagnosis, including complications, and the bacteriologic and pathoanatomic findings. The bacteriologic findings showed 75% alpha-hemolytic streptococci and 25% beta-hemolytic streptococci, and 21% Staphylococcus aureus, 23% Staphylococcus albus, and 6% Escherichia coli. In pure cultures, alpha-hemolytic Streptococcus occurred in 21% and beta-hemolytic in 4%. The alpha-hemolytic and gamma streptococci and Staph. aureus were regarded as apathogenic organisms. The same distribution of bacteria was found both in complicated and in uncomplicated conditions, and little or no correlation between bacteriologic findings and complications or severity of symptoms could be found. As might be expected, the pathologic findings were more marked in cases of complications. The conclusions seem to agree with those of Dohlman, in 1943, who wrote:

> The usual microscopic signs found in chronic tonsillitis are not of any major value. If the microscope cannot determine with certainty the presence or absence of an infection, then it is so much the more difficult for us to decide grossly whether or not the tonsils are infected.

Bryan [13] reports a case of primary tuberculosis of adenoid tissue, with bilateral cervical node involvement, in a 28-year-old white woman. The literature is reviewed, and only a few similar cases are noted. In this case, no other activity could be found, and the patient responded to adenoidectomy and bilateral cervical node removal while receiving streptomycin therapy. According to Bryan, apparently tuberculosis of the tonsils and adenoids in children, with cervical node involvement, does not connotate a poor prognosis; in adults there is frequently pulmonary involvement.

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11. Kao, Y. E.; Feng, S. F., and Yuan, Y. T.: The Occurrence of Hypoglycemia During Acute Tonsillitis in Children: Report of 2 Cases, Chinese M. J. **69**:60 (Jan.-Feb.) 1951.

12. Christofferson, K., & Richtnér, N. G.: Clinical, Bacteriologic and Pathoanatomic Considerations in Chronic Tonsillitis, Acta oto-laryng. **39**:102 (June) 1951.

13. Bryan, J. T.: Primary Tuberculosis of the Adenoids in a 28-Year-Old Nurse: Case Report, J. Tennessee M. A. **44**:293 (July) 1951.

Belal[14] briefly reviews considerations that might account for the presence of tubercle bacilli in tonsils and adenoid tissue and states that there are five possible routes of entrance: (1) inhalation, (2) ingestion, (3) hematogenous, (4) retrograde lymphatic drainage from tuberculous cervical nodes, and (5) sputogenous, when the sputum is loaded with the bacilli. He also presents pathological considerations, including earlier reports of tonsillar tuberculosis, and presents the results of a careful clinical, bacteriologic, and microscopic study of 127 cases of routine adenotonsillectomy in an attempt to find latent foci of tuberculosis. The study included 109 pairs of tonsils and 110 adenoid masses. Bacteriologic examination by direct smears and culture media was performed, and in none of the cases was Mycobacterium tuberculosis seen. Histopathologic examination of serial sections from the removed tonsils and adenoid tissue, plus cervical lymph nodes in three cases, was carried out. The cervical node biopsies all showed typical tubercle formation, with caseation. Only one adenoid mass was found to contain tuberculous foci, and no tonsil examined showed any tuberculosis. Belal agrees with most authors on the subject that most tuberculosis of tonsils and adenoid tissue is primary.

Belal[15] also reports finding bilharzial ova in adenoid tissue removed from the nasopharynx of a 12-year-old boy complaining of nasal obstruction, snoring, and repeated attacks of upper respiratory catarrh. He discusses the normal route of migration of the worms in the body, as well as the several possibilities for explaining this ectopic site for the eggs.

That the tonsils may serve as a true focus of infection is borne out by their anatomical structure, according to György and Székely.[6] The lacunae (crypts) afford optimal conditions for the life and proliferation of bacteria, and such foci may have an effect on the course of general constitutional diseases such as nephritis, endocarditis, and polyarthritis. It is small wonder, then, they say, that attention has been directed toward these crypts in the past. Measures of treatment against them have varied from manual massage for the removal of their contents to injections of phenol into the tonsillar substance. These experiments with injecting materials into the tonsils, however, were carried out prior to the advent of antibiotics; so the authors devised an experiment using penicillin injected into the tonsils and surrounding structures in an attempt to find an answer to the following questions: 1. Does penicillin injected locally into tonsils produce an untoward reaction of irritation? 2. What is the duration of absorption of penicillin from tonsils as compared to that injected intramuscularly or into the tonsillar pillars? 3. How does absorption of crystalline penicillin from tonsils compare with that of "retard" penicillin (penicillin in peanut oil and beeswax)? 4. What is the duration of penicillin retention in the tonsil after injection? 5. How does penicillin injected into tonsils affect the bacterial flora of the mouth and tonsil in normal and in scarlatina patients? They conclude that absorption of penicillin from tonsils is demonstrable and that it is slower and more prolonged than when injected intramuscularly. A markedly quick absorption occurred from the pharyngeal pillars. In scarlatina patients, they could not influence the hemolytic Streptococcus flora of the mouth by

14. Belal, A.: Latent Tuberculosis in Tonsils and Adenoids: Study of 127 Cases, J. Laryng. & Otol. **65**:414 (June) 1951.

15. Belal, A.: Bilharzial Ova in Adenoid Tissue, J. Roy. Egyptian M. A. **34**:41 (Jan.) 1951.

injecting penicillin into the tonsils but observed a transitory decrease in the general bacterial flora of the buccal cavity.

The importance of infections of the lingual tonsil is reiterated by Hoover.[1] He lists as symptoms of acute inflammation pain in the hyoid region or the base of the tongue, possibly referred to the ear or the nasopharynx, and the sensation of a lump in the throat or a frequent desire to clear the throat. There may be difficult and painful swallowing, especially when swallowing only saliva, as well as cough, hoarseness, and sometimes cervical adenopathy. Constitutional reactions, such as fever, chills, leukocytosis, and joint pains, may accompany acute inflammation here, as well as elsewhere in the pharynx. The symptoms of chronic infection of the lingual tonsil are less severe. They include a feeling of a lump in the throat on swallowing, especially without food, chronic cough, and a feeling of a foreign body or irritation. Hoover emphasizes that the lingual tonsil is subject to the same disease processes that affect the other lymphoid tissue masses in the throat and that the proper treatment consists of surgical removal when acute infection is absent.

ANATOMY AND PHYSIOLOGY

No new evidence is introduced into the literature in 1951 regarding the physiologic function of the tonsils, though references are made to such possible function by several writers.

The growth factors and physiology of the lymphoid tissue structures of the pharynx are not well known, according to Hoover.[1] He states that much has been written on the faucial tonsils but that the other lymphoid structures have been neglected, possibly because they are smaller, less easily removed, and consequently considered less important. The function of lymphocyte and other phagocyte production has been known for years, and the "barrier theory" of combating infections has also been described. Inanition is known to bring about a regression in size of lymphoid tissue, and such tissue is known to require essential amino acids, as shown by involution of the tissue and regression of lymphosarcoma implants in pyridoxine-deficient rats. The effects of irradiation and hormones on lymphoid tissue are partially known, but the development of medical treatment to reduce the size of lymphoid tissue is progressing slowly and must proceed with caution because of the possibility of other effects. The role of antibiotics in the treatment of lymphoid tissue infection is mentioned.

In his discussion of indications for adenotonsillectomy, Lederer [2] states that the fact must be accepted that the tonsils are useful portions of the anatomy and should never be removed without positive evidence that removal is necessary. He states that the tonsils and adenoids play an important part in the development of autoimmunization in the young child. At the age of 5 or 6 years, this form of immunization is still incomplete but will continue to flourish if the tonsils are present. Repeated infections will be necessary before the process of immunization is completed. On the other hand, if the structures in question are removed too early, the child is left unprotected and may actually be endangered later on.

The advantage of having repeated tonsil infections and overcoming them is pointed out also by György and Székely.[6] They state, however, that the efficiency of every organ has its limits, and when infection gains the upper hand and the tonsil is no longer able to fulfill its protective function, its removal is indicated. They explain a great deal of the trouble caused by tonsils on the basis of their anatomic

structure. The crypts form a very favorable site for the growth of organisms and may have far-reaching effects on the body by serving as foci of infection.

An interesting case of a developmental tumor of the tonsil is reported by Lewis, Gottstein, and Costanzo.[16] The literature on these rare congenital tonsil tumors is reviewed, and a case of faucial tonsil tumor in a newborn infant is presented. The mass measured 9 by 6 cm. and was attached to the left tonsil by a long, narrow pedicle. Histologic examination revealed varying tissue components. Some areas resembled the cerebral cortex, others the cerebellum; some were largely vascular, and one section had a squamous epithelial covering beneath which was fibroadipose and nerve tissue. Some cartilage, bone, and glands were present. Removal of the mass was followed by complete recovery. The authors present an embryologic explanation for such a tumor.

Reeves and Brill [17] state that because of anatomic structures not usually emphasized simple adenoidectomy is often not sufficient for the relief of nasal obstruction in children. In addition to the salpingopharyngeal folds of lymphoid tissue (the lateral bands), there are two other folds, or bands, which are in closer relation to the choanae and are therefore more important in the production of nasal obstruction. They both begin at the anterior lip of the torus, instead of at the posterior lip. The salpingopalatine fold extends from the anterior lip of the tubal ostium downward directly onto the dorsum of the soft palate to the midline, or it may describe an arc with the concavity toward the ostium. It may be thin and transparent or thick and prominent, depending upon its content of glandular and lymphoid tissue. Direct visualization of this fold may be accomplished by elevating the palate and pressing posteriorly on the adenoid mass prior to its removal. The salpingonasal fold begins at the anterior lip of the torus and runs upward. It may appear as a continuation of the salpingopalatine fold. The authors report a study of 155 children from 2 to 10 years of age. Thirty-eight of them showed hypertrophy of these two folds, some 10 mm., one 12 mm., and one 15 mm. in width. Removal was carried out in 10. Since in children the width of the choanae is 9 mm., any fold with a width approximating that thickness may be important in causing nasal obstruction. The indications for the surgical removal of these folds are (1) obstruction to nasal breathing; (2) lymphoid tissue serving as a nidus for focal infection, and (3) Eustachian tube obstruction from these folds. A sharp conchotome or a No. 2 tonsil punch is used for the removal. The use of Coakely ties to control nasopharyngeal bleeding after adenoidectomy is advised.

TECHNIQUE AND RESULTS

Every surgeon who removes tonsils and adenoid tissue has variations in technique which suit his needs or make the operation easier for him, or which give better results in his hands. Several suggestions are offered for consideration in the literature for 1951.

16. Lewis, G. K.; Gottstein, W. K., and Costanzo, V. A., Jr.: Congenital Neurogenic Malformation of the Faucial Tonsil, A. M. A. Arch. Otolaryng. **54**:172 (Aug.) 1951.

17. Reeves, E., and Brill, R.: More Complete Adenoidectomy to Overcome Interference with Nasal Breathing by the Salpingonasal and Salpingopalatine Folds, Laryngoscope **61**:146 (Feb.) 1951.

Tionloc [18] suggests for trial a method of placing traction sutures either vertically or horizontally through the tonsil for its manipulation at operation, rather than using grasping forceps. He uses 4-0 nonabsorbable suture material. Several advantages for this method are cited. He states that such suture traction does not result in as much tonsil tissue destruction, and since rotation and traction are easier, the pillars are better tensed, allowing for their better recognition and more precise incision of the plicae. The safety factor of keeping the tonsil from falling into the hypopharynx is also mentioned. In children, the decreased encroachment on the size of the field is an added advantage. When local anesthesia is used, Tionloc states, traction sutures cause less gagging and the patient is free to expectorate blood and secretions without the removal of the sutures. The value of the technique is said to be accentuated with friable or submerged varieties of tonsils.

A simple procedure to "considerably reduce" the 4 to 8% incidence of hemorrhage after tonsillectomy is suggested by Hartzell.[19] It consists of the use of right and left DuPuy-Weiss tonsil needles with 2-0 plain absorbable surgical suture U. S. P. to place a suture in the upper part of the tonsil fossa after the dissection and snare technique. The needle is inserted about the middle of the anterior pillar and passes upward and medially just under the fossal structures to emerge either at the base of the uvula or at the middle of the posterior pillar. A surgeon's knot is then tied. The suture catches successively the glossopalatinus muscle fibers, the loose peritonsillar tissues, and the pharyngopalatinus muscle fibers.

Hyde [20] points out that tonsillectomy is the most commonly performed surgical procedure, constituting 25% of all operations. It is done by more different kinds of physicians than is any other operation but it is not always done well, as evidenced by the finding of tonsil tags, or remnants, in from 22 to 80% of cases in various series. For some unknown reason, he states, tonsillectomy seems to be classed in a category by itself with regard to the considerations that govern other surgical procedures, such as hemostasis, exposure, and careful dissection. Several factors combine to make tonsillectomy a fairly difficult procedure. These are limited exposure, depth of the field, difficulty of illumination, and a position leading to apprehension concerning pulmonary complications. Hyde believes that none of these difficulties is insurmountable, and he lists his suggestions for overcoming them. These include the use of the Davis type mouth gag and the occasional use of intratracheal intubation when general anesthesia is employed. When local anesthesia is used, he seats the patient leaning well forward, with the surgeon looking upward into the mouth. This position allows blood and secretions to run downward and out of the mouth, rather than into the pharynx. Sharp dissection is carried out downward to include the lower pole, and no snare is used. The author states that there is no good reason to treat the lower pole differently from the upper pole.

Another contribution to the technique of tonsillectomy is offered by Leivers.[7] He sutures together the upper 5 to 8 mm. of the pillars with two sutures of fine chromic absorbable surgical suture U. S. P. He states that this procedure gains a

18. Tionloc, R. C.: Traction Sutures in Tonsillectomy, A. M. A. Arch. Otolaryng. **54**:198 (Aug.) 1951.

19. Hartzell, M. K.: Simple Procedure to Reduce Post-Operative Tonsil Bed Bleeding, Northwest Med. **50**:936 (Dec.) 1951.

20. Hyde, T. L.: Failure of Tonsillectomy, J. A. M. A. **146**:1478 (Aug. 18) 1951.

little time in the postoperative healing and prevents the formation of a vertical scar tissue band, which sometimes divides a tonsil fossa into two parts.

Additional considerations regarding technique must be entertained when adenotonsillectomy is to be done in the presence of a cleft palate, according to Beatty.[21] He points out that in a child having had a cleft palate repair, hypertrophy and infection of the pharyngeal lymphoid tissue structures may develop, just as in any other child, but precautions must be taken to maintain the deglutitory and phonetic results obtained by the palate repair. Anyone contemplating adenotonsillectomy in these circumstances should keep the following points in mind: 1. If the tonsillectomy is done by any of the accepted methods, natural contractions will, to varying extents, impair the speech and functions of the velum in deglutition. 2. It is the operator's duty not only to remove the infected tonsils but also to prevent impairment of speech and the function of the palate. 3. It is possible in some instances for the operator actually to improve the speech by adopting proper technique. 4. These measures must be taken at the time the tonsils are removed. Later corrective operations are not satisfactory because of contractions of the tonsillar fossae. He then describes his operation, in which, after removal of the tonsils, he partially removes the uvula and splits the borders of the palatopharyngeus muscles as far ventrally as is needed to suture them in the midline to give more depth to the soft palate. He states that when properly done, this procedure obviates much more formidable procedures on the palatal structures later.

Regarding technique, Hoover [1] pleads also for adequate removal of tonsils, stating his preference for dissection and snare over the guillotine method. He invites attention to the lateral pharyngeal bands of lymphoid tissue, and advocates their removal by incision around them, dissecting them upward, and using a snare at the top. He also urges complete removal of adenoid tissue, stating that after proper removal, recurrence of enough to fill the fossae of Rosenmüller is rare, and thus postoperative irradiation postoperatively is needed infrequently. Visualization of the nasopharynx before, during, and after the adenoidectomy is mentioned as being helpful. He also mentions the sitting position of the patient and endotracheal intubation as measures to be employed in avoiding aspiration.

Objective reports of the results of adenotonsillectomy should be of much interest to those doing the operation, both in evaluating the indications for surgery and in prognosticating the results expected. Gale [3] reports on one study in England concerning epidemics in schools. The study involved children over 13 years of age and revealed no significant difference between groups with and without operation in the attack rates of nasopharyngeal infections, scarlet fever, rheumatism, appendicitis, otitis media (with or without mastoiditis), or pneumonia. The group in which operation was done, however, did lose less time from school because of illness. The conclusion drawn was, "There is a tendency for the operation to be performed as a routine prophylactic ritual for no particular reason and with no particular result."

In further attempting to determine whether tonsillectomy accomplishes the ends for which it is done, Gale refers to the earlier work of Kaiser [4] in which 4,400 children were followed. Half of these children had been operated on and half had not. The conclusion was that the short-term (three-year) follow-up revealed relatively greater advantages in the group who underwent operation than did the

21. Beatty, H. G.: Relation Between Tonsil and Adenoid Operations and Cleft Palate, J. A. M. A. **145**:379 (Feb. 10) 1951.

long-term (10-year) follow-up. This result, however, is to be expected, since the number of upper respiratory infections decreases with advancing age in children. In another group of 337 children, Gale found that the operation reduced the number of sore throats and colds, but other findings were more uncertain.

A review of 1,000 cases of tonsillectomy is presented by Hyde.[20] He found residual tonsil tags in 68%. He adds his plea to that of others that more care be expended in the complete removal of tonsil tissue, and presents his results in 262 cases of tonsillectomy done by the technique he advocates, with his precautions and suggestions. All his patients were observed for six months or more, and in 48 cases (18%) some lymphoid tissue could be seen in the fossa after operation, but in only two cases could it be identified as a remnant of tonsil. Thus he reports his cases of tonsillectomy as successful in 99% of 262 cases.

Rhinometric examination is suggested by Stoksted[22] as a means of deciding objectively whether adenoidectomy has resulted in sufficient breathing space. He discusses rhinometry, or the determination of nasal passage permeability, both by indirect and by direct methods. Indirect rhinometry is based on such methods as observing the size and time of duration of condensed moisture patches from the expired air on a plain mirror. Direct rhinometry is based on the determination of the amount, pressure, and velocity of air passing through the nose. Any one of these factors can be determined if the other two are known. The author describes his own method of determining rhinomanometrically the presence or absence of nasal respiratory insufficiency and presents the results of his examinations of normal persons and of school children with adenoid vegetations. He emphasizes the importance of such a method as an adjunct to the objective examination and for purposes of control at follow-up after adenoidectomy.

ANESTHESIA

According to Slater and Stephen,[23] the development of more meticulous techniques in adenotonsillectomy during the last 15 years has come to require longer anesthesia. It should not be taken lightly by those administering the anesthetics, for it is an elective procedure, and there is little excuse for anything going wrong. The anesthetist is faced with the problems of maintaining a proper level of anesthesia, guarding the airway, and avoiding the aspiration of material. He also has a responsibility in avoiding the creation of psychic barriers in children as the result of anesthesia induction. The authors maintain that adenotonsillectomy requires hospitalization, preferably from the afternoon before to 24 hours after the operation. Adequate premedication is essential to good induction, and the postoperative effects of any premedication should be kept in mind. Induction with nitrous oxide or vinyl ether is satisfactory, as is maintenance of anesthesia with ether or nitrous-oxide-oxygen mixture. In their opinion, the only safe way is to include the use of an orotracheal tube inserted when the third plane of anesthesia is reached. The various complications of anesthesia are discussed, as well as suggestions for their avoidance. They state that with such an agent as vinyl ether available, ethyl chloride has

22. Stoksted, P.: Rhinometric Examinations of Schoolchildren with Adenoid Vegetations, Acta oto-laryng. **39**:44 (Feb.) 1951.

23. Slater, H. M., and Stephen, C. R.: Anaesthesia for Tonsillectomy and Adenoidectomy, Canad. M. A. J. **64**:22 (Jan.) 1951.

no place, since it is dangerous and may cause cardiac and respiratory arrest simultaneously.

Jackson [24] states that the preoperative preparation of children for anesthesia is of two types: pharmacologic and psychologic. Since sufficient premedication to produce docility or somnolence may have serious side-effects, the author advocates a method of reducing, by psychologic preparation, the emotional trauma incident to anesthesia. She describes her method, along with the results obtained in 30 cases, and cites the following practical advantages: less anesthetic agent required, quieter inductions, milder excitement stages, lack of physiologic depression from premedication, and quieter operating rooms. Open-drop vinyl ether (Vinethene) was used for induction in all cases because it is rapid in its action, as well as less unpleasant and less irritating than ethyl ether. The importance of a gradual change from vinyl ether to ether "with reduction of the Vinethene drop as the ether was increased" in obtaining a smooth upper second level of anesthesia is pointed out.

On the basis of a report by MacDonald,[25] in which he described the use of isopropyl chloride in adults as an agent with rapid action, lack of irritation to the respiratory mucous membrane, and quick excretion, Lockett [26] used isopropyl chloride in a series of 50 children ranging in age from 3 to 12 years for dissection tonsillectomy. With premedication consisting of atropine and pentobarbital (Nembutal), and induction with nitrous oxide and oxygen, the isopropyl chloride was used in an ether machine as the main agent for anesthesia. Although the advantages were considerable (potent action, rapid induction, small amount required, rapid recovery, and little vomiting), the author found that in children there was almost no margin of safety. The average amount used was only 1 oz. (30 gm.) per patient, but if the concentration was not reduced once deep regular breathing was achieved, respirations rapidly ceased, and the apnea was followed immediately by disappearance of the pulse beat. Even though artificial respiration for a few minutes restored the situation, the author considers the agent unsafe and has discontinued its use.

In an attempt to allay the generalized fear among members of the medical profession with regard to the dangers of cocaine, Furstenberg and his associates [27] present a careful study of 30,000 cases of tonsillectomy done under local infiltration anesthesia with the use of 0.5% cocaine hydrochloride solution containing 2.0% of 1:1,000 epinephrine. The total dose varied between 2 and 10 cc. In the 30,000 cases of tonsillectomy, done over a period of 45 years, there were three fatalities which occurred during the operation and which might be attributed to the anesthetic. One case presents occasion for little doubt that the patient died of cocaine poisoning; in the other two, the patients had concomitant disease—congenital syphilis with syphilitic aortitis in one and coronary thrombosis during surgery in the other. The authors also reported studies of plasma levels and urinary excretion of cocaine in

24. Jackson, K.: Psychologic Preparation as a Method of Reducing the Emotional Trauma of Anesthesia in Children, Anesthesiology **12**:293 (May) 1951.

25. MacDonald, T. J. C.: A Preliminary Report on the Anaesthetic Properties of Iso Propyl Chloride, Brit. J. Anaesth. **22**:92 (April) 1950.

26. Lockett, J.: Isoprophyl Chloride as an Anaesthetic for Tonsillectomy, Brit. J. Anaesth. **23**:117 (April) 1951.

27. Furstenberg, A. C.; Wood, L. A.; Magielski, J. E., and McMahon, G. F.: An Evaluation of Cocaine Anesthesia: The Perpetuation of Equivocal Concepts, Trans. Am. Ophth. **55**:643 (July-Aug.) 1951.

21 cases of local tonsillectomy and in seven cases of submucous resection of the nasal septum in which 0.6 gm. of cocaine crystals was applied topically. The highest observed plasma level in the tonsillectomy group was 1.6 γ per cubic centimeter and in the submucous resection group 0.4 γ per cubic centimeter. The amounts of cocaine recovered in the urine were essentially the same in both groups. That these levels fall well within the safety range is claimed on the basis that in dogs the plasma level of cocaine at the onset of convulsions is about 4. to 7.0 γ per cubic centimeter in the intact animal, though it is admitted that such a comparison between two species is not necessarily valid. The report makes no attempt to woo physicians from their present methods of anesthesia, and no attempt is made to compare the toxicity of various anesthetic agents. The conclusion is that when carefully employed (and no anesthetic should be carelessly used) cocaine is a reliable, safe, and effective anesthetic for tonsillectomy.

Since the use of intravenous procaine has been reported to be of benefit in controlling post-traumatic and postoperative pain in other parts of the body, Somers [28] tried it in post-tonsillectomy cases. He used it in 41 cases, in 18 of which the patients received 10 cc. of a 1.0% solution of procaine hydrochloride U. S. P., in 20, 10 cc. of a 2.0% solution, and 3, 20 cc. of a 2.0% solution, all given slowly over a five-minute period. Analgesia of the tonsil fossae occurred for an average of two hours (2 to 9½ hours), but no patient requested another injection. The practicality of the method was not considered to be high because of the unpleasant symptoms occurring during the injection, and its routine usage is not recommended.

COMPLICATIONS

Wright and Pray [29] review the opinions concerning the effects of various preoperative and postoperative medications on secondary bleeding after tonsillectomy and report on two series of cases totalling 1,648 cases of adenotonsillectomy. The first series comprised 411 cases in which the patients were allowed free use of acetylsalicylic acid, but alternate patients received ascorbic acid (150 mg. on the day before operation, 150 mg. on the day of operation, and 100 mg. per day for 10 days after operation). Of the control group, 7.7% had secondary hemorrhage, and of the group receiving ascorbic acid, 7.2%. The second series consisted of 667 cases, 82 of which were local tonsillectomies in adults. All the patients received vitamin K before and after the operation. Of the children who received acetylsalicylic acid, 17.4% had secondary hemorrhage, while only 1.5% of those not receiving it had any secondary bleeding. The 82 adults all received both ascorbic acid and vitamin K. Of those receiving acetylsalicylic acid in addition, 20% had secondary hemorrhage, while only 3% of those who did not take acetylsalicylic acid bled secondarily. The authors conclude that acetylsalicylic acid given after adenotonsillectomy increases the incidence of late secondary hemorrhage, but ascorbic acid has no appreciable effect, and vitamin K appears to have no antihemorrhagic effect.

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28. Somers, K.: Intravenous Procaine Following Tonsillectomy, Ann. Otol. Rhin. & Laryng. **60**:175 (March) 1951.

29. Wright, W. K., and Pray, L. G.: Factors Influencing Late Secondary Hemorrhage Following Tonsilloadenoidectomy, A. M. A. Arch. Otolaryng. **53**:277 (March) 1951.

An attempt was made by Pearlman and Loewy [30] to correlate with barometric pressure and outside temperature the postoperative incidence and time of secondary bleeding after adenotonsillectomy. They studied 1,035 cases of adenotonsillectomy in children done under general anesthesia (vinyl ether induction and ether vapor maintenance). When acetylsalicylic acid was given postoperatively, it was given in addition to ascorbic acid and vitamin K. Delayed secondary hemorrhage occurred in 4.347%. During the three-year period of observation, 77.7% of the bleeding occurred on the fifth, sixth, and seventh postoperative days. Of this, 30% occurred with falling barometric pressure, while 46% occurred with rising barometric pressure. They do not conclude that temperature and pressure conditions cause postoperative bleeding but state that on the basis of their findings, it is conceivable that the time of its occurrence may be altered by the prevailing conditions of these factors.

Mention is made under the head of Technique and Results of several methods which are said to reduce the incidence of secondary bleeding after adenotonsillectomy.

No doubt there will be those who will take issue with the inclusion here of a report of articles on the possible relationship between poliomyelitis and adenotonsillectomy. That there is a relationship, though not a causal relationship, and perhaps not a closer relationship than exists between poliomyelitis and other elective surgery, one may be called upon to admit. If one concedes that there is validity to the several reports showing an increased incidence of the bulbar type of poliomyelitis within 30 days after adenotonsillectomy, then one submits at least to the thesis that there is some merit to the conservative viewpoint, which advises postponement of the operation during times and at places with increased incidence of poliomyelitis.

Miller [31] studied the 1,229 cases of poliomyelitis which occurred in Los Angeles County during the 1949 epidemic in an attempt to answer three questions: 1. Do recent tonsillectomy and adenoidectomy increase the patient's chances of contracting poliomyelitis? 2. If poliomyelitis is contracted, do recent tonsillectomy and adenoidectomy increase the chances that the bulbar type will develop? 3. Should tonsillectomy and adenoidectomy be discontinued during the summer months when the incidence of poliomyelitis is the highest? His data were analyzed by a statistician, and "the results of the statistical analysis indicate no clinical or statistical significant deviation between the actual and the expected incidence of poliomyelitis developing in Los Angeles County during 1949 in patients recently tonsillectomized and adenoidectomized, even in the months of July through October." He concludes that there is no evidence to support discontinuing adenotonsillectomy during the summer months.

On the other hand, MacGregor [32] reviews the literature on the subject and points out that there is much more evidence supporting a causal relationship between poliomyelitis and tonsillectomy than evidence to the contrary. He states

30. Pearlman, S. J., and Loewy, A.: Secondary Tonsillar and Adenoid Hemorrhage in Relation to Barometric Pressure Changes, A. M. A. Arch. Otolaryng. **53**:527 (May) 1951.

31. Miller, A. H.: Tonsillectomy and Adenoidectomy and Poliomyelitis, A. M. A. Arch. Otolaryng. **53**:160 (Feb.) 1951.

32. MacGregor, I. W.: The Relationship of Poliomyelitis and Tonsillectomy, J. Laryng. & Otol. **65**:289 (April) 1951.

that the evidence seems to support the assumption that if tonsillectomies are done during an epidemic, the patients are more apt to contract poliomyelitis and more liable to contract the bulbar type. He reminds the reader that most of the reports on the subject are American in origin and that, even though his impression is that similar figures would not be obtained from studies in England, impressions are not enough in so serious a question. He pleads for more statistical information obtained through the English Ministry of Health in order to help clarify the situation.

A report of six cases of poliomyelitis occurring within 15 days after adenotonsillectomy is presented by Goerke and Bower.[33] In five of the six cases the disease was bulbar in type. They conclude that their report corroborates other published opinions that deferment of elective adenotonsillectomy should be carried out during periods of increased poliomyelitis incidence and that the bulbar type of the disease is significantly more frequent when it develops after adenotonsillectomy. In Los Angeles, they state, the incidence of poliomyelitis is greatest from June through November, and the Los Angeles City Health Department has recommended deferment of elective tonsil and adenoid surgery during that period.

Faber and his associates [34] state that the difference in incidence within 30 days after tonsillectomy of bulbar poliomyelitis, as compared to that of the spinal type, is greater than can be explained on the basis of pure chance. They state that this indicates a causal relationship between the operation and the bulbar localization of the disease. Previous attempts to prove this have been unsuccessful, and they believe it is because in order to consistently produce infection in a divided nerve, it is necessary to apply the virus to the central cut end before it is sealed off by blood. They explored two hypotheses in a study on monkeys: the first, "that virus already in the pharynx is directly introduced into the peritonsillar musculature, which is unavoidably traumatized during the human operation, and hence into its supplying nerves"; the second, "that localized traumatic stresses to these muscles tend to localize paralyses in them, presumably by making their supplying nerve centers in the medulla more vulnerable to the effects of poliomyelitic infection already present in the central nervous system." Using a 17% suspension of the Wis '45 strain (Brunnhilde type) of poliomyelitis virus on monkeys previously prepared by division of the olfactory tracts to preclude entry by the olfactory route and varying the tonsillectomy-poliomyelitis sequence, they arrived at the following conclusions: When virus was applied to the pharynx of monkeys prior to tonsillectomy, the operation was followed regularly after 7 to 10 days by primary bulbar paralysis, accompanied less often by high spinal paralysis. The authors believe that this effect was due to the introduction of the virus into the peritonsillar tissues. When tonsillectomy was done three days after the intrathalamic inoculation of the virus, bulbospinal paralysis followed two days later, and the authors state that this effect probably indicates that trauma increases central nervous system vulnerability to infection. After swabbing of the oropharynx with virus and no tonsillectomy, spinal paralysis usually developed (in four of seven monkeys), and bulbar paralysis, in only one. In six animals, the application of 2% iodine tincture one-half

33. Goerke, L. S., and Bower, A. G.: Poliomyelitis Following Tonsillectomy: A Report of 6 Cases, Ann. West. Med. & Surg. **5**:770 (Sept.) 1951.

34. Faber, H. K.; McNaught, R. C.; Silverberg, R. J., and Dong, L.: Experimental Production of Post-Tonsillectomy Bulbar Poliomyelitis, Proc. Soc. Exper. Biol. & Med. **77**:532 (July) 1951.

minute after the virus was applied, and just before tonsillectomy, resulted in no development of paralysis. Further study of the possible value of such preoperative antisepsis is required before its value can be assessed.

Since human gamma globulin has been shown to contain neutralizing antibodies against the three known types of poliomyelitis virus, Adams and his associates [35] conducted an experiment using concentrated human gamma globulin in an attempt to modify or prevent experimental poliomyelitis in tonsillectomized cynomolgus monkeys. In two groups of monkeys, one group of 22 animals receiving intramuscular injections of 1.0 ml. of gamma globulin per pound (0.5 kg.), and another group of 44 animals receiving 2.0 ml. per pound, no significant differences were observed between treated and untreated animals. Eleven in the first group and 20 in the second group were tonsillectomized by the snare method under ether anesthesia. Mouse neutralization tests carried out 30 days later failed to show evidence of poliomyelitis antibodies in the nontonsillectomized controls, but some evidence of antibody production was noted in animals that were tonsillectomized and had been given gamma globulin. An attack rate of poliomyelitis of 20% (9 of 45 monkeys) was observed in tonsillectomized animals fed virus by mouth, whereas in the nontonsillectomized control group of 20 monkeys fed the same virus in identical dosage, no poliomyelitis developed.

A conservative note is struck by Lederer,[2] who states, "It would seem that postponement of an elective procedure is in the public interest and to the advantage of the physician during epidemics." Gale [3] believes that the problem now is more when to do adenotonsillectomy than whether to do it, considering that the incidence of poliomyelitis reaches its peak in summer and autumn. He mentions a survey in England in 1949 in which 16 cases were reported as occurring within one month after tonsillectomy. Four of the patients died of the bulbar type (two were brothers), seven had the spinal type and recovered, and one had no paralysis. He says the risk of bulbar poliomyelitis developing after tonsillectomy is admittedly remote but is one which should not be taken when the virus is widely distributed among the population, except in those rare cases in which the operation is really a matter of urgency.

Various rare complications of adenotonsillectomy continue to be reported in the literature, such as the report by Bishoff and co-authors [36] of the occurrence of brain abscess after operation. They review the literature on the subject and add three cases to the small number of reported cases of brain abscess following the operation. In none of the three cases was there any inflammation of the structures at the time of surgery. The route was apparently hematogenous, and the authors state that undoubtedly bacterial emboli do occur at times after adenotonsillectomy and give rise to symptoms, but the damage repairs itself without permanent sequelae. Although brain abscess is a rare complication, it should be kept in mind, along with the possibility of any intracranial disorder developing shortly after surgery. The authors believe that in some cases in which poliomyelitis following adeno-

35. Adams, J. M.; Carpenter, C. M.; French, J. D.; Pressman, J. J.; Smith, J. L., and Klein, S. J.: Experimental Poliomyelitis: Use of Human Gamma Globulin in Tonsillectomized Monkeys, Laryngoscope **61**:1010 (Oct.) 1951.

36. Bishoff, H. W.; Leyva, F. R.; Rice, E. C., and Haymaker, W.: Brain Abscess as a Complication of Tonsillectomy and Adenoidectomy: with a Clinicopathologic Report of 3 Fatal Cases, M. Ann. District of Columbia **20**:429 (Aug.) 1951.

tonsillectomy was suspected, and in which autopsy was not done, such complications as they report may have been present. The authors recommend the routine use of chemotherapy or antibiotics preliminary to and following surgery of the upper respiratory tract.

Froeschels [37] discusses the organic and functional insufficiency of the velum, known as rhinolalia aperta, or hyperrhinolalia (the audible passage of air through the nose at an inappropriate time), following adenoidectomy and/or tonsillectomy. He presents some interesting and helpful tests to find out whether "nasality" of the voice is present prior to surgery. He does not deny that the condition may result from scarring or habitual perpetuation of unextensive movements of the palate due to postoperative pain, but he does state that in his experience no case of postoperative hyperrhinolalia has been found in which there were not at least slight signs of the condition before operation. He presents a case of hyperrhinolalia which was wrongly assumed to be due to adenotonsillectomy. Ideally, every possible subject for the operation should be examined by a logopedist to avoid any of several inconveniences. If hyperrhinolalia is present, and he states that there are many cases which go unnoticed except by a trained phonetician, the surgeon may reconsider whether or not the operation must be performed for reasons of general health or of local ear damage due to Eustachian tube obstruction.

A case of massive "spontaneous" pneumoperitoneum in a 15-year-old girl occurring immediately after tonsillectomy under ether anesthesia is reported by Rogers and Jones.[38] Small bowel obstruction, with adhesion of the ileum to the uterus, occurred about a week after operation and was corrected surgically. Various possible explanations for the development of pneumoperitoneum are offered, but the respiratory tract would seem to be ruled out as a possible route of air entry.

As important points to be observed in preventing complications of adenotonsillectomy, Lederer [2] lists the following: competence and experience of the operator; hospitalization for several hours before surgery; full explanation of the procedure to the patient; avoidance of surgery during acute infections or during epidemics; consideration of oral and dental status; detailed preoperative instructions; adequate premedication and skilled anesthetists; head-low posture, with continuous suction during the procedure; complete removal of tonsil tissue; complete hemostasis, and proper postoperative care and observation. He also lists several factors influencing the prognosis: (1) faulty operative technique; (2) incorrect preoperative diagnosis due to inattention to predisposing factors or to lack of careful study and intelligent interpretation of the clinical picture; (3) ill-advised time of operation; (4) finding a "sign" which is not there, and (5) dependence upon doubtful methods, or a "command performance" wherein the operator is "told" to take out the tonsils and adenoids.

IRRADIATION THERAPY

Only two references to irradiation therapy for hypertrophied nasopharyngeal lymphoid tissue appear in the 1951 literature. Hoover [1] pleads for adequate removal of this tissue at adenoidectomy and states that after proper removal recurrence to

37. Froeschels, E.: "Postoperative" Hyperrhinolalia (Rhinolalia Aperta), A. M A. Arch. Otolaryng. **54**:140 (Aug.) 1951.

38. Rogers, A., and Jones, F. W.: Pneumoperitoneum Following Tonsillectomy, Gastroenterology **19**:349 (Oct.) 1951.

the extent of causing nasal obstruction or of filling the fossae of Rosenmüller is rare and that irradiation will be needed infrequently. He advises caution in the use of this modality and believes that its use is indicated only when the lymphoid tissue is present in small amounts that are surgically inaccessible. Lederer [2] includes a warning against the indiscriminate use of radiant energy in the nasopharynx by those inexperienced in its use.

In evaluating the status of surgical treatment of malignant tumors of the tongue, tonsils, and hypopharynx, Orton [39] points out that 10% of buccal cancers originate in the tonsil, and it is often hard to ascertain the exact site of origin, since the pillars and tongue are often involved. Lymphatic drainage of these regions is abundant, and metastases occur early and extensively. The first symptom is often a node in the neck. The value of surgery is admittedly limited. Small tumors, with or without metastases, are more suitable for combined excision and block dissection of the neck. He cites the case of one patient living 11 years after such a procedure. The prognosis in these cases from a surgical standpoint is not too good but has recently become better, especially in lymphoepithelioma. Lymphosarcoma and transitional sarcoma have a better prognosis than squamous-cell carcinoma.

The radiologist's viewpoint on this same group of tumors is presented by Lampe.[40] He states that it is important to segregate true tonsillar tumors from those arising in adjacent tissues, since the prognosis in the former is better. The ability of irradiation to sterilize the tumor is greater for true tonsillar lesions if local involvement is not excessive. Initial determination of the site of origin may be impossible, but as the tumor regresses under therapy, the original site will be the last to disappear. He states that tonsillar tumors are the most frequently mismanaged, with the possible exception of malignant nasopharyngeal tumors, and that much time is lost in chemotherapy, incisions and drainage, tonsillectomies, and neck dissections. He considers tonsillectomy to be a useless procedure in malignant tonsillar tumors and cites eight cases in which the patients had been referred for irradiation therapy at varying intervals after tonsillectomy. In two of the cases, there was no opportunity to evaluate the surgery, since irradiation had been begun immediately after operation. In five, recurrence of the tumor occurred from immediately after operation to less than a year later. In one, a rapidly growing metastasis developed in the upper neck immediately after tonsillectomy. So the procedure was proved to be useless in six of the eight cases. Lampe's summary of the situation is as follows:

> Except perhaps for the uncommon tumor of salivary gland origin, the malignant tumors which arise in the tonsil are solely radiotherapeutic problems. Proper irradiation from both standpoints of technic and dosage will eradicate the disease in the primary site and in the cervical metastatic areas. Surgical dissection of the neck is not necessary; indeed with these undifferentiated, aggressively malignant tumors, it is undesirable. At the present time the cure rate for skillful radiotherapy of true tonsillar malignancies is of the order of 30% five-year cures. This rate is not higher chiefly because of the many mistakes which are currently being made in the management of this disease. To elevate the cure rates, no new methods of treatment are required; only better management is needed.

39. Orton, H. B.: Symposium: Malignant Tumors; Malignant Neoplasms of the Tongue, Tonsils and Hypopharynx: Evaluation of Surgical Treatment, Tr. Am. Acad. Ophth. **55**:226 (Jan.-Feb.) 1951.

40. Lampe, I.: Symposium: Malignant Tumors; Malignant Neoplasms of the Tongue, Tonsils and Hypopharynx: Evaluation of Radiation Therapy, Tr. Am. Acad. Ophth. **55**:231 (Jan.-Feb.) 1951.

Hirst and Charland review the literature on lymphosarcoma of the tonsil and presents two cases. They state that it is rare in adults and very rare in children. Clinically, it is characterized by marked hypertrophy of one tonsil, with a dull hyperemic appearance and a soft nodular structure. Ulceration and hemorrhage are often present. In the differential diagnosis, one must consider infectious adenopathy and lymphatic diathesis. In these conditions, there is moderate lymph node enlargement, which is not so progressive in its extension, and pain is much more pronounced. The treatment, he states, consists of tonsillectomy first, removing as much of the tumor as possible, followed by irradiation therapy. The prognosis is usually poor, since the early stages of the disease are asymptomatic. Patients are not seen early as a rule, and there is a tendency for the patients to regard early improvement from treatment as indicative of a "cure." In the chronic form of the disease, the numerical status of the red blood cells and the infiltration of the skin and subcutaneous tissues, as well as of the deeper organs, may be used as criteria for judging the advancement of the process. The authors emphasize the importance of suspecting malignancy when there is unilateral tonsillar or cervical node enlargement, especially when it is progressive and unaccompanied by tenderness.

Hoover [1] cautions against overlooking malignant nasopharyngeal tumors and points out several diagnostic points to be utilized. He advocates routine biopsy of any suspicious tissue or its surgical removal and microscopic examination.

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41. Hirst, O. C., and Charland, R. A.: Lymphosarcoma of the Tonsil: Review of Literature and Report of 2 Cases, A. M. A. Arch. Otolaryng. **54**:60 (July) 1951.

Special Reports

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Goldentone Models 25, 69, & 97
Mfr., Johnston Hearing Aid Mfg. Co.
708 W. 40th St.
Minneapolis 8

Distr., Goldentone Corporation
708 W. 40th St.
Minneapolis 8

Maico Model J

Maico Quiet Ear Models G & H

Maico Top Secret Model L

Maico UE Atomeer
Mfr., The Maico Company, Inc.
21 N. 3rd St.
Minneapolis 1

Mears (Crystal & Magnetic) Aurophone Model 200
Mfr., Mears Radio Hearing Device Corporation
1 W. 34th St.
New York 1

Micronic Model 303

Micronic Model Mercury

Micronic Star Model
Mfr., Audivox, Inc.—Successor to Western Electric Hearing Aid Division
123 Worcester St.
Boston 18

Microtone Classic Model T-9

Microtone Models T-10, T-612, & 45
Mfr., The Microtone Company
Ford Parkway on the Mississippi
St. Paul 1

National Cub Model (C)

National Model D (Duplex)

National Standard Model (T)

National Star Model (S)

National Ultrathin Model 504

National Vanity Model 506
Mfr., National Hearing Aid Laboratories
106 S. 7th St.
Philadelphia 6

Normatone Model C
Mfr., Johnston Hearing Aid Mfg. Co.
708 W. 40th St.
Minneapolis 8
Distr., Normatone Hearing Aid Co.
22 E. 7th St.
St. Paul 1

Otarion Model E-4

Otarion Models F-1, F-2, & F-3

Otarion Models G-2 & G-3

Otarion Model H-1
Mfr., Otarion, Inc.
4757 N. Ravenswood Ave.
Chicago 40

Paravox Model D (Top-Twin-Tone)

Paravox Model J (Tiny-Myte)

Paravox Model Y (YM, YC, & YC-7)
(Veri-Small)
Mfr., Paravox, Inc.
2056 E. 4th St.
Cleveland 15

Radioear All-Magnetic Model 55

Radioear Permo-Magnetic (Multipower)

Radioear Model 62 Starlet

Radioear Model 72

Radioear Model 82 (Zephyr)
Mfr., E. A. Myers & Sons, Inc.
306 Beverly Rd.
Mount Lebanon
Pittsburgh 16
Distr., Radioear Corporation

Rochester Models R-1 & R-2
Mfr., Rochester Acoustical Laboratories, Inc.
117 Fourth St., S. W.
Rochester, Minn.

Silvertone Models J-92 & P-15
Mfr., Johnston Hearing Aid Mfg. Company
708 W. 40th St.
Minneapolis 8

Distr., Sears, Roebuck and Co.
925 S. Homan Ave.
Chicago 7

Solo-Pak Model 99
Mfr., Solo-Pak Electronics Corp.
Linden St.
Reading, Mass.

Sonotone Models 900, 910, 920, 925, 940, & 966
Mfr., Sonotone Corporation
Elmsford, N. Y.

Super-Fonic Hearing Aid
Mfr., American Sound Products, Inc.
1303 S. Michigan Ave.
Chicago 5

Televox Model E
Mfr., Televox Mfg. Company
1307 Sansom St.
Philadelphia 7

Telex Models 97, 99, 200, 300-B, 400, 500, 952, 953, & 1700

Mfr., Telex, Inc.
Telex Park
St. Paul 1

Tonamic Model 50
Mfr., Tonamic, Inc.
12 Russell St.
Everett 49, Mass.

Tonemaster Cameo Model

Tonemaster Model Royal
Mfr., Tonemaster, Inc.
400 S. Washington St.
Peoria 2, Ill.

Unex Midget Models 95 & 110

Unex Models 200 & 230
Mfr., Nichols & Clark
Hathorne, Mass.

Vacolite Models J & J-2
Mfr., Vacolite Company
3003 N. Henderson St.
Dallas 6, Texas

Western Electric Models 65 & 66
Mfr., Audivox, Inc.—Successor to Western Electric Hearing Aid Division
123 Worcester St.
Boston 18

Zenith Miniature 75

Zenith Model Royal

Zenith Model Super-Royal

Zenith "Regent"
Mfr., Zenith Radio Corporation
5801 W. Dickens Ave.
Chicago 39

(All the accepted hearing devices have vacuum tubes.)

Accepted hearing aids more than five years old have been omitted from this list for brevity.

SEMIPORTABLE HEARING AIDS

Ambco Hearing Amplifier (Table Model)
Mfr., A. N. Brooks Company
684 S. Bonnie Brae St.
Los Angeles 5

Aurex Semi-Portable
Mfr., Aurex Corporation
1117 N. Franklin St.
Chicago 10

Precision Table Hearing Aid
Mfr., Precision Hearing Aids
5157 W. Grand Ave.
Chicago 39

Sonotone Professional Table Set Model 50
Mfr., Sonotone Corporation
Elmsford, N. Y.

News and Comment

AMERICAN OTOLOGICAL SOCIETY, INC.

The American Otological Society, Inc., awarded its gold medal and a scroll to Dr. Julius Lempert at its Annual Meeting in New Orleans on May 1, 1953. The award was given to Dr. Lempert for his outstanding contribution to the surgery of the temporal bone. The scroll which accompanied the gold medal bore the following inscription:

THE AMERICAN OTOLOGICAL SOCIETY, INC.

1953

AWARD OF MERIT GOLD MEDAL

PRESENTED TO JULIUS LEMPERT, M.D.

Your investigations, carried on through trials which would have discouraged a lesser figure, have so perfected the fenestration operation that your technique is accepted throughout the world and is regarded as a boon to mankind.

Your remarkable studies, superior surgery and inspiring teaching mark you as the one who has made the greatest single contribution to otology in this generation.

CASSELBERRY AWARD OF THE AMERICAN LARYNGOLOGICAL ASSOCIATION

A sum of money having accrued from the Casselberry Fund of the American Laryngological Association, a prize will be offered in 1954 for original investigation in the art and science of laryngology or rhinology. Manuscripts must be in the hands of the Secretary, Dr. Harry P. Schenck, 326 S. 19th St., Philadelphia 3, before March 1, 1954.

Directory of Otolaryngological Societies *

FOREIGN AND INTERNATIONAL

Canadian Otolaryngological Society
(Société Canadienne d'Otolaryngologie)

President: Dr. D. E. S. Wishart, 170 St. George St., Toronto.
Secretary: Dr. W. Ross Wright, 361 Regent St., Fredericton, N. B.
Place: Minaki Lodge, Minaki, Ont. Time: June 14-18, 1953.

Fifth International Congress of Oto-Rhino-Laryngo-Broncho-Esophagology

Place: Amsterdam. Netherlands. Time: June 8-13, 1953.
President: Prof. Dr. Eelco Huizinga.
General Secretary: W. H. Struben, Viottastraat 1, Amsterdam-Z
Scientific Secretaries: Dr. J. Bijtel and Dr. P. G. Gerlings.

International Bronchoesophagological Society

President: Dr. Fernand Eeman, Ghent, Belgium.
Secretary: Dr. Chevalier L. Jackson, 1901 Walnut St., Philadelphia 3.
Meeting: Second International Congress of Bronchoesophagology.
Place: Albert Plage, Le Zoute, Belgium. Time: June 15-16, 1953.

International Congress of Audiology

Place: Leyden, Netherlands. Time: June 5-6, 1953.
General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Holland.

International Course in Paedo-Audiology

Place: Groningen, Netherlands. Time: June 1-4, 1953.
General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Holland.

Pan American Association of Oto-Rhino-Laryngology and Broncho-Esophagology

Meeting: Fourth Pan-American Congress of Oto-Rhino-Laryngology and Broncho-Esophagology.
Place: México, D. F., Mexico. Time: Feb. 28-March 4, 1954.
President: Dr. Justo Alonso.
Exec. Secretary: Dr. Chevalier Jackson, 1901 Walnut St., Philadelphia 3.
President of Congress: Dr. Ricardo Tapia Acuna.

Third Latin-American Congress of Otorhinolaryngology and Bronchoesophagology

Place: Caracas, Venezuela. Time: Feb. 21-25, 1954.

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. Dean Lierle, Iowa City.
Secretary: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis 3.
Place: San Francisco.

American Academy of Ophthalmology and Otolaryngology

President: Dr. James Milton Robb, 315 Lakeland Ave., Grosse Pointe 30, Mich.
Executive Secretary-Treasurer: Dr. William L. Benedict, 100-1st Ave. Bldg., Rochester, Minn.
Place: Palmer House, Chicago. Time: Oct. 11-17, 1952.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

American Board of Otolaryngology

President: Dr. LeRoy A. Schall, 243 Charles St., Boston.
Secretary-Treasurer: Dr. Dean M. Lierle, University Hospitals, Iowa City.
Place: Roosevelt Hotel, New Orleans. Time: April 21-25, 1953.

American Broncho-Esophagological Association

President: Dr. Fred W. Dixon, 1027 Rose Bldg., Cleveland.
Secretary: Dr. Edwin N. Broyles, 1100 N. Charles St., Baltimore 1.
Place: Roosevelt Hotel, New Orleans. Time: April 28-29 (afternoons only).

American Laryngological Association

President: Gordon F. Harkness, 215 Main St., Davenport, Iowa
Secretary: Dr. Harry P. Schenck, 326 S. 19th St., Philadelphia 3.
Place: Hotel Statler, Boston. Time: May 20-21, 1954.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. Francis E. LeJeune, 49 Audubon Blvd., New Orleans 18.
President-Elect: Dr. LeRoy A. Schall, 243 Charles St., Boston.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester 7, N. Y.
Place: Roosevelt Hotel, New Orleans. Time: April 28-30, 1953 (mornings only).

SECTIONS:

Eastern.—Chairman Dr. Irl H. Blaisdell, 1100 E. Genesee St., Syracuse 10, N. Y.
Place: Hotel Syracuse, Syracuse, N. Y. Time: Jan. 7, 1953.
Southern.—Chairman: Dr. W. W. Wilkerson, Jr., Curtiswood Lane, Nashville 4, Tenn.
Place: Andrew Jackson Hotel, Nashville, Tenn. Time: Jan. 12, 1953.
Middle.—Chairman: Dr. Henry L. Williams, 818 4th St., S. W., Rochester, Minn.
Place: The Drake, Chicago. Time: Jan. 19, 1953.
Western.—Chairman: Dr. Alden H. Miller, 4000 Woking Way, Los Angeles 27.
Place: The Elks Club, Los Angeles. Time: Jan. 24, 1953.

American Otological Society, Inc.

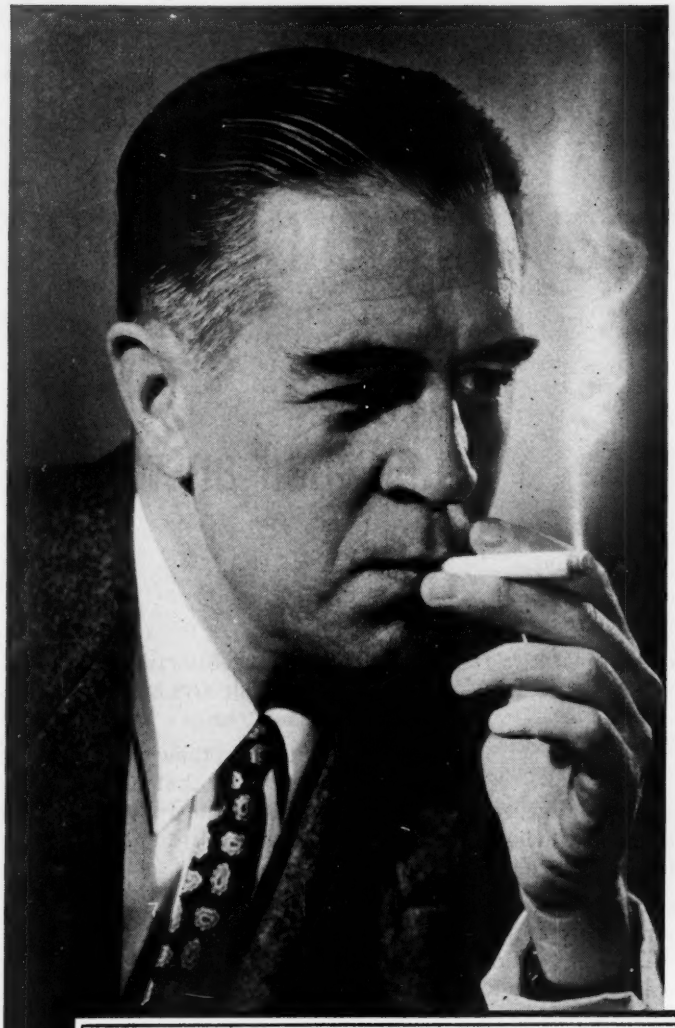
President: Dr. Frederick T. Hill, Professional Building, Waterville, Maine
Secretary-Treasurer: Dr. John R. Lindsay, 950 E. 59th St., Chicago.
Place: Boston. Time: May 16-17, 1954.

American Otorhinologic Society for the Advancement of Plastic and Reconstructive Surgery, Inc.

President: Dr. Benjamin H. Shuster, 1824 Pine St., Philadelphia.
Secretary: Dr. Louis Joel Feit, 50 Park Ave., New York 16.

American Society of Ophthalmologic and Otolaryngologic Allergy

President: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
President-Elect: Dr. Albert D. Reudemann, 1633 David Whitney Building, Detroit 26.
Secretary-Treasurer: Dr. Michael H. Barone, 468 Delaware Ave., Buffalo 2.
Place: Palmer House, Chicago. Time: Oct. 16, 1953.



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With so many claims made in cigarette advertising, you, Doctor, no doubt prefer to judge for yourself. So won't you make this simple test?

Take a PHILIP MORRIS and <u>any</u> other cigarette

1. Light up either one first. Take a puff—get a good mouthful of smoke—and s-l-o-w-l-y let the smoke come *directly* through your nose.

2. Now, do exactly the same thing with the other cigarette.

You will notice a distinct difference between PHILIP MORRIS and <u>any</u> other leading brand.

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Philip Morris & Co. Ltd., Inc., 100 Park Avenue, New York 17, N. Y.

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Q: What materials are used in cigarette filters?

A: Until just recently, cellulose, cotton or crepe paper were the only materials used in cigarette filters.

Now, after long search and countless experiments, KENT's "Micronite"* Filter has been developed. It employs the same filtering material used in atomic energy plants to purify the air of minute radio-active particles.

Q: How effective are these cigarette filters?

A: Scientific measurements have proved that cellulose, cotton or crepe paper filters do not take out a really effective amount of nicotine and tars.

However, these same tests also have proved that KENT's exclusive Micronite Filter *approaches 7 times the efficiency of other filters in the removal of tars and nicotine* and is virtually twice as effective as the next most efficient cigarette filter.

Q: Do physiological reactions to filter cigarettes differ?

A: The drop in skin temperature occurring at the finger tip induced by filtered cigarette smoke was measured according to well-established procedures. (a, b)

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filter cigarettes that to you, Doctor

the makers of Kent

rettes, the drop was over 6 degrees. For KENT's Micronite Filter, there was no appreciable drop.

Q: Does an effective cigarette filter also remove the flavor?

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References Cited

a. *J.A.M.A.*, Vol. 103, 1934, p. 318
b. *J.A.M.A.*, Vol. 135, 1947, p. 417

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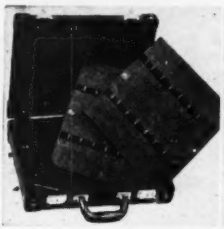

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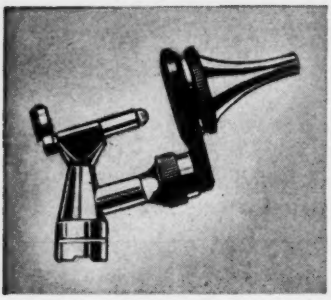

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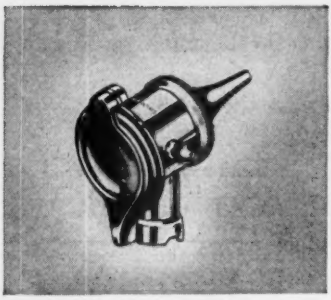

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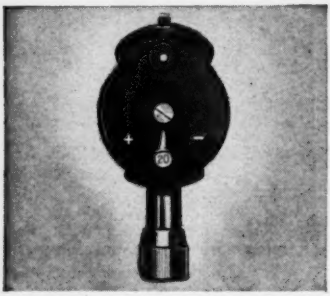

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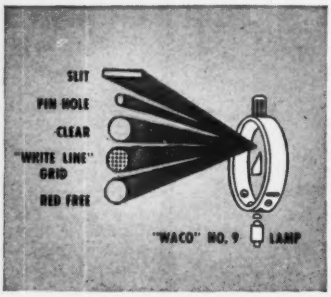

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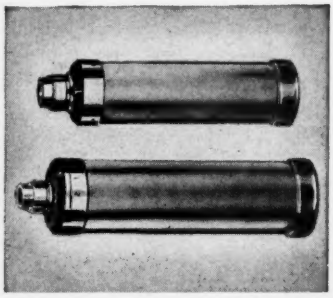

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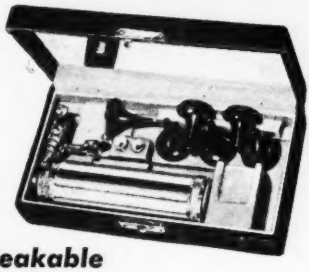

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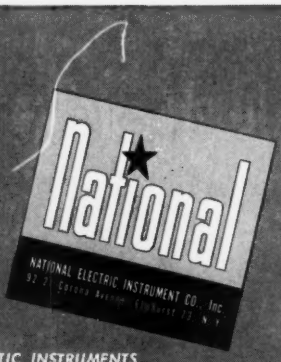

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1. Van Alyea, O. E., and Donnelly, Allen: Arch. Otolaryng., 49:234, Feb., 1949.

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